# Algae Biofuels Neg

# Solvency

## Solvency

### Solvency – Picking Winners Bad

#### The status quo solves the aff - natural competition will drive the algae biofuel commercialization – but the aff picks a winner which collapses the market

Jeffrey Decker, 6/22/2009, Renewable Energy World, “Blooming biofuel: how algae could provide the solution,” <http://www.renewableenergyworld.com/rea/news/article/2009/06/blooming-biofuel-how-algae-could-provide-the-solution?cmpid=WNL-Wednesday-June24-2009>

That observation is apparent in their plan to provide algae oil to fuel refiners. One focus at LiveFuels, Jones says, is algae growing in conjunction with different kinds of microbes and in conjunction with higher level life forms like fish. ‘We think those systems are going to be a lot more robust and a lot less likely to crash than systems that are going to be based on just one set of algae. Healthy competition will help everyone,’ he says, ‘there ought to be plenty of opportunities for companies to play together as they optimize the process.’¶ In the meantime, production costs are becoming more competitive with fossil-derived alternatives. For instance, the Netherlands’ Algae Link CEO, Peter van den Dorpel, says: ‘We could offer the full chain of algae-to-fuel and be competitive with the fossil fuel market at the level of $100/barrel. Our algae-growing systems today are showing these productivity levels and we are scaling-up production capacity.’ Their demonstration units are small enough to ship and can be scaled upward, he says, mostly to customers planning to grow high-end diet supplements. ‘Sometimes the CO2 issue is the main driver. They don’t even care where the end product goes,’ van den Dorpel adds, noting: ‘We’ve sold more than 30 units in about 20 countries.’¶ Among the oldest players is Ingrepro Micro Ingredients, and director C. Callenbach says they’re competitive today. ‘If oil doesn’t go below $42/barrel, then it gets into the break-even,’ he asserts. This year the company is building four ‘energy farms’ – a combination of wastewater treatment and algae plant. ‘You produce biomethane and at the same time you produce biomass,’ he says, adding: ‘On 30 hectares the low cost we can achieve is 70–80 tonnes per hectare.’¶ Ingrepro holds claim to being the largest industrial algae producer in Europe, but they don’t stress themselves on breaking new scientific frontiers. ‘It’s not the system that does it. It’s a combination of the systems and you have to have good management,’ Callenbach says. ‘There are companies focused on convincing people to use their system. We use any system. We are not married to anybody.’¶ Even so, Callenbach worries the hype promoted by algal newcomers is hurting the overall industry. ‘Some are honestly over-optimistic and some aren’t,’ he remarks, saying: ‘There are a lot of companies that fooled a lot of people.’¶ As Ingrepro moves outside of food production they’re looking past automobiles and straight into kerosene for jet aircraft. So far, ‘Whatever kerosene we make is very easy to sell, because everybody wants it. It’s a niche market. In the next two years we will be able to lower the cost of our kerosene more.’¶ As leader of Boeing’s biomass research, Darrin Morgan has also noticed companies over-selling their abilities to produce. ‘It’ll be apparent in the next year who the people are who are talking about it and who are the ones doing it,’ he says.¶ Though several airlines are still testing innovative alternative fuels in their commercial jet liners, Morgan says Boeing has concluded that phase of its own research. He has already watched the available fuel selection rapidly grow from almost nothing, and notes: ‘The great thing is that the innovation is happening in a wide spectrum of places, from two people in a garage with a great idea, all the way to major research and development places in the government sector.’¶ As an emerging technology with a huge potential and an even bigger demand it is perhaps inevitable that some players are tempted to hype claims for yields as they search the markets for development finance. Some claims will inevitably turn to dust as the real commercial winners emerge and some are revealed as dead ends. But with the range of technologies available and a ground swell of R&D investment cash, confidence among developers is high that algae-derived biofuels will soon be able to compete with fossil fuels.

### Solvency – Demonstration Fails

#### Numerous examples prove government backed algae demonstrations fail

Jeffrey Decker, 6/22/2009, Renewable Energy World, “Blooming biofuel: how algae could provide the solution,” <http://www.renewableenergyworld.com/rea/news/article/2009/06/blooming-biofuel-how-algae-could-provide-the-solution?cmpid=WNL-Wednesday-June24-2009>

The European Union is throwing €2.7 billion behind algae over seven years, and is including algae for the first time in the 2010 calls of its Seventh Framework Programme. Individual countries, particularly in Western Europe, are supporting research and expansion as well.¶ Nonetheless, some government-backed programmes have failed to live up to expectations. For instance, the Japanese government’s Research for Innovative Technology of the Earth programme spent $100 million studying closed algae systems, but ultimately gave up on it. While in 1996 the United States closed its US Aquatic Species Program, which led research over three decades at two 1000 m² open-pond systems, before concluding the technology was too expensive for large-scale production.

### Solvency – No Commercialization (OMEGA specific)

#### OMEGA doesn’t work - four reasons.

Schwartz 11

Interview about NASA’s OMEGA project [HOME](http://www.algaeindustrymagazine.com/) / [A.I.M. INTERVIEWS](http://www.algaeindustrymagazine.com/department/a-i-m-interviews/) / AIM INTERVIEW: NASA’S OMEGA SCIENTIST, DR. JONATHAN TRENT August 21, 2011, by David Schwartz UNIVERSITY OF CALIFORNIA, MERCED Microalgae Cultivation using Offshore Membrane Enclosures for Growing Algae ¶ (OMEGA) A dissertation submitted in partial satisfaction of the requirements ¶ for the degree Doctor of Philosophy in Environmental Systems by Patrick Edward Wiley [AlgaeIndustryMagazine.com](http://www.algaeindustrymagazine.com/)http://www.algaeindustrymagazine.com/nasas-omega-scientist-dr-jonathan-trent/

I think that there are four major areas with formidable hurdles some of which apply to all algae systems and some of which are particularly true for OMEGA because it’s not an established technology.¶ Those four “obstacle” areas (in no specific order of importance) are:¶ 1. Biology, which includes finding the right strains of algae that grow well in wastewater and form a stable community. For OMEGA, they also have to die in seawater.¶ 2. Engineering, which is a problem in the OMEGA system because the marine environment is daunting both in terms of materials and corrosion as well as strength and longevity with 5, 10, and 100 year storms. This depends on where you are, but even in places like the North Sea there is some pretty amazing engineering going on to pursue oil in deep water. In addition to deepwater oil drilling platforms, there are plans for large floating airports and even floating cities, being developed in Holland to anticipate sea level rise. I somehow think our engineering ingenuity is up to the challenge of developing OMEGA systems at least in protected bays for now, in the new bays that will form in the future with sea-level rise, and maybe someday in the open ocean. 3. Economics, the OMEGA project itself is facing an economic crisis of sorts because we are going to run out of money at the end of this calendar year and we are looking for funding for our next Phase, but that’s not relevant to the overarching economic challenge. In general, the economics of large-scale algae cultivation for a commodity like biofuel, is considered a major issue. I would argue that the economics of an OMEGA system will be based on the integrated system of both products and services. The products include algae biofuels, biogas, fertilizer, and aquaculture harvests. The services include wastewater treatment and carbon sequestration and to some degree environmental remediation, if OMEGA can be used like the “turf scrubber” system.¶4. Environmental obstacles, which have environmental impact and social components. The marine component is how OMEGA impacts the local marine environment. The fact that it’s going to clean up wastewater outfalls is a positive impact, but there are open questions about marine mammals and sea birds, and shading the local eco systems. I think the overall impact will be positive, but that remains to be determined.

#### Omega founder concedes algae will interrupt commerce, can’t withstand open ocean, and is unlikely any time soon

Hoppin 12 (Jason Hoppin, staff reporter for the Santa Cruz Sentinel, “A green future: NASA's $10 million project explores algae of as fuel source” 5/18/12 http://www.santacruzsentinel.com/ci\_20658615/green-future-nasas-10-million-project-explores-algae)

Trent said he sees future algae plants taking up several hundred sea acres near the shore, which is likely to raise questions about shipping and fishing traffic, not to mention views. He does not believe they could withstand being deep in the open ocean.¶ Looking other places¶ He also doesn't expect to see the large-scale domestic production of algae during his lifetime, saying it would probably be tried elsewhere first, possibly Southeast Asia.¶ The nature of algae-based biofuels makes it appropriate for some uses, but not for others. And researchers say breaking the nation's dependence of foreign oil still will take a mix a renewable sources and conservation.¶ "There is no magic bullet to solving our energy needs," said Sigrid Reinsch, a NASA cellular biologist originally hired in response to critiques of how the agency staffed its space programs, but who had been searching for meaningful research before connecting with the OMEGA Project.

#### Omega founder concedes algae isn’t viable on a wide scale, can’t replace enough fuel

Trent 12 (Jonathon Trent, NASA astrobiologist and founder of OMEGA, literally invented the aff, “Grow Your Own Energy: A NASA-backed experiment harvests algae for oil, releases fresh water.” New Scientist. September 3, 2012)

But there are big unsolved problems at which governments should be throwing funds and brainpower as if we were involved in a Manhattan project. For example, since few species of microalgae have been domesticated, we don't know how to grow them reproducibly or economically. At what scale will algae farming be efficient? To put this in perspective, U.S. planes use 80 billion liters of fuel per year. To supply this fuel from microalgae at the lower end of the estimated production rate would take 4.2 million hectares—twice the area of Wales.

#### OMEGA is not commercially viable – multiple hurdles remain

Michael Coren, 4/27/2012, Fast Coexist, “NASA’s got a brand new bag, and it’s full of algae” <http://www.fastcoexist.com/1679739/nasas-got-a-brand-new-bag-and-its-full-of-algae>

Algae is among the most efficient converters of sunlight to energy in the form of oil, but the process to harvest it has been beset with expensive complications: overcrowding, overheating, microbial competition, and other issues that have kept the sector well below commercial volumes for more then a decade.¶ NASA’s $10 million, two-year project has at least shown that it’s possible for floating plastic bags full of algae and wastewater to yield as much as 2,000 gallons of biofuel per acre annually under favorable conditions. This solves a few problems associated with land-based bioreactors, lowers costs, and takes advantage of open waters to grow the fuel. However, the bags’ integrity in seawater, and their ultimate disposal, remain problematic, as does the system’s economics: NASA is studying whether the numbers will actually support a commercial venture.

#### OMEGA can’t be scaled up

Trent 12 (Jonathon, studied at Scripps Institution of Oceanography, UC-San Diego, specializing in extremophiles. He is lead scientist on the OMEGA project at NASA's Ames Research Center in California. Prepared for: California Energy Commission Prepared by: NASA Ames Research Center “OFFSHORE MEMBRANE ENCLOSURES FOR GROWING ALGAE (OMEGA) A Feasibility Study for Wasterwater to Biofuels” California Energy Commission. Publication number: CEC‐500‐2013‐143. December 2012, <http://www.energy.ca.gov/2013publications/CEC-500-2013-143/CEC-500-2013-143.pdf)//EAZYE>

While the OMEGA system revenue was significantly higher than the WWT-BNR system (Fig. 6-left “Rev”), both the capital and operating costs were also much higher and therefore the revenue required was higher. The direct capital costs for construction, engineering fees, and other costs gave a direct total for the WWT-BNR ($45.4M) and for WWT-OMEGA ($547M), which were divided into different cost sectors (Fig. 6: pie charts-right). The three largest direct cost sectors for the WWT-BNR were membranes (34 percent), BNR (28 percent), and aeration/nitrification (20 percent), which account for 82 percent of the total costs (Fig. 6, bottom-right). The three largest direct costs for the OMEGA capital costs were PBR-PVC components (38 percent), the pumps (31 percent), and the offshore platform (21 percent), which account for 90 percent of the total (Fig. 6, top-right).Obviously, the full-scale WWT-OMEGA system, based on the extrapolated experimental system, was prohibitively expensive, but the purpose of this study was to adhere to a direct scale-up of the experimental OMEGA design.

#### OMEGA has technological and economic problems.

Worldpress.com 2013

OMEGA: the next big energy source?¶ [September 6, 2013](http://gwphysics.wordpress.com/2013/09/06/omega-the-next-big-energy-source/) http://gwphysics.wordpress.com/2013/09/06/omega-the-next-big-energy-source/#

The need for sustainable energy in the form of biofuels is a topic we often hear from politicians today. But is this vision possible in our lifetime? How can we go about creating this energy and harnessing it for use in our cities? Dr. Jonathan Trent and his team of NASA scientists have begun their research on a system they call OMEGA (Offshore Membrane Enclosure for Growing Algae). This system uses large, semi-permeable plastic bags filled with wastewater and algae. The algae grow from the nutrients in the wastewater and they remove nitrogen and phosphates. The algae also perform photosynthesis in the bags, releasing oxygen into the air and turning carbon dioxide into clean water. The clean water is produced by the filtered bags that perform forward osmosis, a process driven by the osmotic potential in the dirty water, to clean the wastewater. Interestingly enough, forward osmosis does not require an outside energy source for this filtration. The algae in the OMEGA system produce biofuels around 2,000-5,000 gallons per acre a year, according to Trent’s research. This is much more than soybeans (50 gallons/acre a year), sunflowers (100 gallons/a yr.), canola (160 gallons/a yr.), or palm oil (600 gallons/a yr.). In addition to the energy collected, the sewage is processed and used as food for the algae. Skeptics of the system have pointed out a few underlying problems: the constant need for freshwater due to evaporation, the massive amounts of algae needed to produce a substantial amount of energy, the potential for boats hitting the bags, and the possible release of an invasive species if the bags were to break. Many are also wondering if the price to build and run such a system is worth the amount of energy extracted. In my opinion, the benefits of the OMEGA system far outweigh the obstacles presented. Although there isn’t enough energy produced per acre in a year to power a city, the system offers a sustainable alternative to fossil fuels. Dr. Trent has taken biological precautions to prevent the algae from being an invasive species so the surrounding marine environment stays safe. This system is not the end of the road for biofuel production but rather a huge step forward. With research and adjustments OMEGA’s biofuel production could grow even further in the next few years. Since OMEGA is one of the newest systems for biofuels there has to be some adjusting by the public. As a society we can’t close off opportunities for sustainable energy due to small inconveniences in travel, particularly when only 43% of domestic oil requirements were met domestically. OMEGA is a revolutionary system that has the potential to changethe way we capture energy and move us from energy dependence to energy independence in the future.

#### The OMEGA tech isn’t ready

Wiley 2013

Microalgae Cultivation using Offshore Membrane Enclosures for Growing Algae (OMEGA)¶ Author:¶ Wiley, Patrick Edward¶ Acceptance Date:¶ 2013¶ Series:¶ UC Merced Electronic Theses and Dissertations¶ Degree:¶ Ph.D., Environmental SystemsUC Merced¶ Advisor(s):¶ Campbell, Elliott, Harmon, Thomas¶ Committee:¶ Beman, Michael, Trent, Jonathan D¶ Permalink:¶ http://escholarship.org/uc/item/0586c8p5An objective of the OMEGA project was to dewater microalgae, concentrate ¶ nutrients within the PBR and discharge clean water using forward osmosis (FO) ¶ membranes built into the PBR modules. FO is well suited for this application because the ¶ osmotic gradient between the freshwater in the PBR and the surrounding seawater drives ¶ the process (2). Early experimentation by OMEGA scientists confirmed the validity of ¶ this approach by quantifying microalgal dewatering rates (3) and demonstrating that ¶ nutrient concentration using FO can stimulate microalgal growth (Figure 2.1). However, ¶ issues related to membrane fouling and durability prevented this technology from being integrated larger prototype deployments. Instead, PBR tubes were constructed using ¶ either polyurethane or linear low-density polyethylene (LLDPE).

### Solvency – No Commercialization (Hype)

#### Be skeptical of their solvency evidence – algae industries consistently overhype the ability of biofuels to be cost competitive with oil

Justin Moresco, 6/15/2009, Gigaom, “algae-based biofuels moving ever so slowly to market,” <http://gigaom.com/2009/06/15/algae-based-biofuels-moving-ever-so-slowly-to-market/>

Of course, biofuel startups have been known to make aggressive claims about their growth trajectories, only to fall short once the realities of competitive fuel markets took hold. GreenFuel Technologies, a Cambridge, Mass.-based algal-derived fuel maker, had daring production estimates before it started struggling to raise funding. It went on to cut nearly half its staff and then finally closed down last month.¶ Pike Research forecasts that the combined biodiesel and ethanol markets will reach $247 billion in sales by 2020, up from $76 billion in 2010. Clint Wheelock, managing director of Pike, said in a statement that the biofuels market in the near term looks like a “train wreck” (expensive feedstocks, global recession, oversupply) but that in 10-15 years’ time, its outlook is very positive. While startups like Sapphire won’t be waiting on the sidelines for another decade to ramp up production, the reality is that it will take that long (or longer) before these technologies are ready to compete against crude oil.

### Solvency – No Commercialization

#### Algae biofuel won’t be cost competitive – at best, it will still be twice the price of fossil fuel

Michael Hannon et al., 8/8/2011, National Institutes of Health, “biofuels from algae: challenges and potential,” <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3152439/>

With current estimates of algal-based biofuels ranging from US$300–2600 per barrel based on current technology, technical hurdles need to be overcome to improve this price. Some of these improvements can come from improving growth strategies and engineering, as discussed previously, but improvements can also come from optimizing the use of the entire organism. Although the final price of a barrel of algae oil when production goes to large scale is difficult to extrapolate from the present small production facilities, system improvements will certainly bring costs down. Figure 5 illustrates our estimates of the relative impacts of technological improvements on the economic viability of algae biofuels. Most analysts do not predict full parity with petroleum in the near future. More likely, the initial selling point of algal fuels will be approximately twofold higher than petroleum, but the environmental costs will be substantially lower than our current strategy of depending on fossil fuels.

#### Numerous alt causes prevent algae biofuel commercialization

Michael Hannon et al., 8/8/2011, National Institutes of Health, “biofuels from algae: challenges and potential,” <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3152439/>

The high growth rates, reasonable growth densities and high oil contents have all been cited as reasons to invest significant capital to turn algae into biofuels. However, for algae to mature as an economically viable platform to offset petroleum and, consequently, mitigate CO2 release, there are a number of hurdles to overcome ranging from how and where to grow these algae, to improving oil extraction and fuel processing. The algal biofuels production chain is outlined in Figure 3 and shows that the major challenges include strain isolation, nutrient sourcing and utilization, production management, harvesting, coproduct development, fuel extraction, refining and residual biomass utilization.

#### Data surrounding algal biofuels is overstated—there’s no way to make energy conversion competitive

Chanakya 12 “Algal biofuels are no energy panacea,” published in SciDev magazine. Hoysall Chanakya is Principal Research Scientist at the Centre for Sustainable Technologies, Indian Institute of Science, Bangalore. 11/6/12. (http://www.scidev.net/global/biotechnology/opinion/-algal-biofuels-are-no-energy-panacea-.html)

Contested productivity claims¶ Algal productivity is widely contested. Most productivity data are derived from small-scale studies, with projections ranging between 18–360 tonnes per hectare each year. The higher values arise from feeding sugar and providing light for 18–24 hours daily to the algal system.¶ Algal cultivation is likely to be in open pond systems where yields are likely to be in the range of 5–10 grams per square metre daily. The perceived higher yields in sterile monocultures in laboratories are difficult to replicate in the field where a host of algae feeders and algal competitors thrive. In typical fast-growing algal ponds, nearly 30–40 per cent of the algal biomass is consumed by grazers and feeders.¶ Studies show that in short growth cycles of 5–10 days lipid accumulation is at best a paltry 10–15 per cent; and reaches 80 per cent in cycles beyond 30 days. It is misleading to multiply the highest lipid content of 80 per cent with the upper limit of yields of 360 tonnes per hectare per year (obtained by feeding sugar and artificial light at one to three per cent energy efficiency) to project a potential yield of 288 tonnes from every hectare each year. In the field, a potential oil yield in the range of three tonnes per hectare each year would be more realistic.¶ And the energy and solvent needs for oil extraction operations are still unclear. Unless very efficient processes are evolved, algal biofuel extraction would have poor energy balance.¶ Making algae ecologically competitive is something few understand. If we do not resolve the issues, we will end up with a system similar the current model of poorly sustainable, high-input agriculture, something that we don't need and would like to avoid.

#### No commercialization—lack of financing, tech, and crowdout

Wagner 7 “Biodiesel from Algae Oil,” Leonard Wagner. July 2007. (http://www.fao.org/uploads/media/0707\_Wagner\_-\_Biodiesel\_from\_algae\_oil.pdf)

¶ Main obstacles to realization ¶ Besides the challenges in Algaculture, there are some other obstacles to the realization of Algae oil ¶ projects: ¶ ¶ Financing. Although specialized VC firms in this sector are rare, there have been some ¶ interesting developments recently – notably with the involvement of big players like Khosla ¶ Ventures among others. ¶ ¶ Technology. Most companies only conduct R&D and are only nearing commercialisation in ¶ years to come. ¶ ¶ Competition. There are many small start-up companies in the sector. We can assume that ¶ some bigger companies will emerge out of the group of early-stage businesses – potentially ¶ making market-entry more difficult. ¶ ¶ Intellectual property. As of now patents do not really play a role yet. But in the foreseeable ¶ future, especially when the technology becomes mature and the companies are nearing ¶ commercialisation, patents could play an important role in this sector.

#### Algae biofuels have too long of a timeframe – 3 warrants

Christi 13 (Yusuf, PhD, Professor in Biochemical engineering at Massey University. July 12th 2013. “Constraints to commercialization of algal fuels” http://www.tamu.edu/faculty/tpd8/BICH407/Chisti%202013%20Journal%20of%20Biotechnology.pdf)//EAZYE

The impediments to commercialization of algal fuels are many: impossibly high demands on certain key resources; the high cost of production; and the need to achieve an energy ratio of well above unity. Potential solutions to all these issues are being investigated and production of certain niche fuels such as jet fuel may become feasible up to a certain scale. A widespread availability of algal fuels is certainly not likely in the near term. Consumption of petroleum continues to increase. Replacing a significant fraction of this consumption with algal oil cannot happen without development of new technologies. Focused research both on algal biology and the engineering of the production systems is necessary. In addition, peripheral but enabling technologies — carbon dioxide concentration from the atmosphere, for example — need to be developed to make algal fuels feasible. Interest in commercial production of algal fuels continues to be strong, suggesting that the possibility of an economically viable production at some scale and within a reasonable timeframe should not be totally discounted

### Solvency – Not Cost Competitive

#### Algae biofuels won’t be cost competitive with fossil fuels

Kate Galbraith, 12/9/2008, New York Times, “the promise of algae,” <http://green.blogs.nytimes.com/2008/12/09/the-promise-of-algae/>

Algae have gotten short shrift in the decade or so since the Clinton administration axed its research funding at the National Renewable Energy Laboratory. But could these tiny, ubiquitous plants, which come in a rainbow of colors and varieties, get us off of foreign oil some day?¶ “One of the big challenges — price, price, price,” said Michael Webber, a professor at the University of Texas. Right now, he said, algae could make fuel for around $10 a gallon, whereas the objective is to get the price down to $1.¶ The University of Texas is home to what is probably the world’s largest algae collection, with close to 3,000 different strains. Many are little green or red plumes in tubes; others sit in a liquid nitrogen deep-freeze — so cold that if you were to stick a finger in there for a few seconds, it might get lopped off if you banged it against something, according to Jerry Brand, the collection’s director.¶ Algae — whose predecessors helped make oil tens of millions of years ago — are already used in vitamins and other nutritional supplements. But the price is too high and the scale too small to meet the nation’s energy needs.

### Solvency – Insufficient CO2

#### No source of large enough CO2 production capable for meeting output demands

Bracmort 13 “Algae’s Potential as a Transportation Biofuel,” Kelsi Bracmort, Specialist in Agricultural Conservation and Natural Resources Policy. 4/1/13. (http://fas.org/sgp/crs/misc/R42122.pdf)

The primary challenge for ABB is that it has not yet been demonstrated to be affordable at ¶ commercial scale.16 This type of demonstration, preferably from monitoring a large-scale facility, ¶ would be critical to gauging the potential impact ABB could have on the national transportation ¶ fuel network. Also, as mentioned above, algae cultivation requires significant amounts of CO2, ¶ and there are questions about where this CO2 would come from. While the CO2 could come from ¶ existing stationary sources, it may be incorrect to assume that all algae processing facilities would ¶ be located near existing sources of CO2 or that enough CO2 from existing sources would be ¶ available to meet demand for commercial levels of ABB production. It is likely that siting and ¶ permitting of these facilities would require involvement of local, state, and federal government ¶ agencies.

#### Algal biofuels unfeasible— too much CO2 needed for creation process

Christi 13 “Constraints to commercialization of algal fuels,” Yusuf Chisti. 22 July 2013. (http://www.tamu.edu/faculty/tpd8/BICH407/Chisti%202013%20Journal%20of%20Biotechnology.pdf)

¶ Carbon dioxide is essential for growing algae for biofuels. Production¶ of each ton of algal biomass requires at least 1.83 tons of¶ carbon dioxide (Chisti, 2007). Nearly all pilot scale algae culture¶ depends on purchased carbon dioxide that contributes substantially¶ (∼50%) to the cost of producing the biomass. Algae culture for¶ fuels is not feasible unless carbon dioxide is available free (Chisti,¶ 2007). Potentially, carbon dioxide emitted by coal-fired power stations¶ can be used for growing algae, but the amount of available¶ carbon dioxide is a major limitation for large scale culturing of¶ algae.¶ The dispersed tailpipe carbon dioxide emissions that are a consequence¶ the use of petroleum as transport fuel cannot be directly¶ used for growing algae. Concentrated sources of carbon dioxide¶ are mainly the flue gases produced during power generation from¶ combustion of coal. The cement industry is another source of concentrated¶ carbon dioxide emissions. In 2008, coal burning power¶ plants in the US produced 1945.9 million metric tons of carbon¶ dioxide (U.S. Department of Energy, 2009). In the same year, the¶ use of petroleum transportation fuels released 1889.4 million metric¶ tons of carbon dioxide in the US (U.S. Department of Energy,¶ 2009). In comparison, the cement manufacture in the US generated¶ only 42.2 million metric tons of carbon dioxide (U.S. Department of¶ Energy, 2009). If 10% of the carbon dioxide emitted annually¶ from the US coal-fired power stations (∼1.5 billion tons in 2012; U.S. Energy Information Administration:¶ www.eia.gov/todayinenergy/detail.cfm?id=7350) can be converted¶ to algal biomass, nearly 82 million tons of algal biomass¶ could be produced. At 40% by weight oil in the biomass and¶ 95% oil recovery, this is equivalent to 31 million tons of algal¶ crude oil annually, or nearly 27,982 million liters of petroleum.¶ (In energy terms, on average, 1 L of petroleum is equivalent to¶ 1.25 L of algal crude oil (Chisti, 2012).) This is the equivalent of¶ about 9 days of the total 2010 consumption of petroleum in the¶ US. Clearly, therefore, the availability of point sources of carbon¶ dioxide is a major impediment to production of algal fuel oils¶ at a meaningful scale. Although algal biomass with a total lipid¶ content of at least 40% by dry weight can be readily produced¶ in outdoor processes (Quinn et al., 2012), the logic of relying on¶ carbon dioxide from burning coal or other fossil fuel, to produce¶ algal oil is flawed: no oil can be produced unless fossil fuels are¶ burned.

### Solvency – Storms

#### Storms will destroy algae farms

Bruton et al. 9 “A review of the Potential of Marine Algae as a Source of Biofuel in Ireland.” Feb 2009 Tom Bruton (BioXL) Dr Henry Lyons (Shannon Applied Biotechnology Centre) Dr Yannick Lerat (European Research Centre for Algae, CEVA) Dr Michele Stanley (Scottish Association for Marine Science, SAMS) Michael Bo Rasmussen (National Environmental Research Institute, NERI)

http://www.seai.ie/Publications/Renewables\_Publications\_/Bioenergy/Algaereport.pdf

If offshore cultivation is to be developed, infrastructure design in difficult environmental conditions must be improved. Locations exposed to seasonal storms require specific engineering to avoid loss or damage of material and structures. There have been several reports of whole seaweed farms being swept away after years of operation and major investments (Chynoweth, 2002).

#### OMEGA will fail – multiple system problems

Bullis 12 (Kevin, Staff writer, “NASA Wants to Launch Floating Algae Farms” 4/11/12 MIT review http://www.technologyreview.com/news/427475/nasa-wants-to-launch-floating-algae-farms/)//EAZYE

The setup is meant to solve some of the difficulties with making inexpensive fuels from algae. Algae need fertilizer to grow quickly, and wastewater is an excellent source of that. But large sources of wastewater—big cities—don’t have the space needed for the artificial ponds that algae are typically grown in. Pumping the water to areas where land is cheap and plentiful is expensive and energy-intensive. Clear containers called photobioreactors might take up less space, but those, too, are expensive. A few years ago, Trent wondered if floating plastic bags could serve as relatively cheap bioreactors. They don’t need as much support as land-based ones—at least if they’re floating on protected bays. And they solve another major problem with conventional bioreactors, which get too hot from sitting in the sun, and require expensive cooling systems as a result. In Trent’s plastic bag system, the surrounding water helps keep the bags cool. But while it may solve some problems—and it’s far from clear that the bags will prove superior to ponds or other photobioreactors—the system creates others. Trent acknowledges, for example, that there will be an “enormous amount of plastic” to dispose of. The plastic could be recycled, although cleaning out the algae may be difficult. A better option may be reusing it, he suggests. For example, it could be used to replace the black plastic that many farmers in California cover their fields with to reduce weeds and evaporation. The approach will face several other challenges. Working in corrosive saltwater environments is very difficult. And it’s not clear how well the bags would survive storms.

### Solvency – Oceans Insufficient

#### Can’t solve—would need space equivalent to the size of half the Gulf of Mexico

Hendricks et al. 11 <http://www.hindawi.com/journals/ijrm/2011/782969/>¶ International Journal of Rotating Machinery “Aviation Fueling: A Cleaner, Greener Approach” Volume 2011 (2011), Article ID 782969, 13 pages. [Robert C. Hendricks](http://www.hindawi.com/20587450/),1 [Dennis M. Bushnell](http://www.hindawi.com/78502196/),2 and [Dale T. Shouse](http://www.hindawi.com/61328153/)3. First too are NASA scientists and the third worksfor Wright-Patterson Air Force Base

By 2026, world liquid fuels [[1](http://www.hindawi.com/journals/ijrm/2011/782969/#B1), [2](http://www.hindawi.com/journals/ijrm/2011/782969/#B2)] demand is projected to grow by 20–25%, implying an increased US demand from over 20 million bbl/day (2007) to 24 million bbl/day. Even if algae could be grown on the open seas fed by continent-sized nutrient streams under the most opportune of conditions and converted to oils, in order to meet that demand with alternative fuels, the equivalent volume demand would require nearly half the Gulf of Mexico, 0.8 million km2 (Assumes equivalency between refined barrels of plant oil and petroleum. The Ami Ben-Amotz algae production is (0.8 × 1012 m2) (0.02 kgbiomass/m2-day) (3/10 gal/kg) (1/42 bbl/gal) (20% bio-oil/biomass), and the John Benneman algae estimate is (0.8×1012 m2) (4.2×103 gal bio-oil/ha-yr) (10−4 ha/m2(1/365 yr/day) 1/42 bbl/gal).).

#### No space for massive cultivation sites and reactors damage the environment

FAO 9 “ALGAE-BASED BIOFUELS: A Review of Challenges and Opportunities for Developing Countries,” FAO. Food and Agriculture Organization of the United Nations. May 2009. (http://www.fao.org/fileadmin/templates/aquaticbiofuels/docs/0905\_FAO\_Review\_Paper\_on\_Algae-based\_Biofuels.pdf)

Much of the spatial area at sea has existing uses, for example for nature, shipping, ¶ fishery, recreation, military training grounds and offshore infrastructure. ¶ (Florentinus et al., 2008). Finding cultivation space that has not been claimed for ¶ other uses may prove difficult. Conflicts may arise from changing existing use to ¶ seaweed production. Another important aspect to be mentioned is the potential ¶ damage to ecological or species balance in the ocean, when algae is mass ¶ cultivated in parts of the ocean where they were previously not present in large ¶ populations, along with the potential decline in oxygen concentration in the water at ¶ night which might kill other species. ¶ ¶ Further, the design of sea-based cultivation systems has to guarantee the ¶ prevention of sea mammals and other wildlife getting entangled in it (Florentinus et ¶ al., 2008; Reith et al., 2005).

#### Use of freshwater for algae biofuels is inevitable—evaporation, oil extraction

Christi 13 “Constraints to commercialization of algal fuels,” Yusuf Chisti. 22 July 2013. (http://www.tamu.edu/faculty/tpd8/BICH407/Chisti%202013%20Journal%20of%20Biotechnology.pdf)

The supply of freshwater is insufficient to support any substantial¶ scale production of algal fuels anywhere. Supply of brackish¶ water is also relatively limited. Therefore, use of seawater and¶ marine algae are the only realistic options for making algal fuels.¶ Using seawater for algae culture, unfortunately, does not totally¶ eliminate the need for freshwater. Freshwater is needed to compensate¶ for evaporative losses and a consequent increase in culture¶ salinity. Evaporative loss depends on the local climatic conditions,¶ particularly on the irradiance level, the air temperature, the wind¶ velocity and the absolute humidity (Chisti, 2012). For example,¶ in a dry region such as Goodlands, Western Australia (25◦14\_S,¶ 123◦55\_E), the average monthly evaporation rate is 241.4 mm¶ (Chisti, 2012). A freshwater evaporation rate of 10 L m−2 d−1 has¶ been mentioned for some tropical areas (Becker, 1994). This is¶ equivalent to 0.01 m3m−2 d−1, or 10 mm d−1.¶ Freshwater is necessary also for washing the biomass of salt¶ prior to extraction of the oil (see Section 2.2.1). Therefore, production¶ efforts focused on using freshwater algae species are¶ shortsighted. To minimize consumption of freshwater, evaporative¶ loss must be minimized. This may require a combination of¶ closed production facilities and water recycling strategies (Pate¶ et al., 2011). In addition, the location should be selected to minimize¶ evaporation. Cultivation perhaps in shallow seas, saline lakes, constructed¶ marine wetlands (Liu et al., 2012a,b) located adjacent to¶ coastal areas may be some options. Use of halophilic marine algae¶ that can withstand elevated salt levels, may be the way to go, but¶ too high a salt concentration will incur a metabolic cost because the¶ cell must either pump out the excess salt, or produce compounds¶ that allow it to maintain an osmotic balance (Chen and Jiang, 2009).

#### Offshore OMEGA systems have regulatory and environment issues

Trent, Jonathan. (NASA Ames Research Center). 2012. OMEGA (Offshore Membrane Enclosurs

for Growing Algae) ‐ A Feasibility Study for Wastewater to Biofuels. California Energy

Commission. Publication number: CEC‐500‐2013‐143.

The solution for coastal cities may be to cultivate oil-producing microalgae in floating enclosures called photobioreactors (PBRs) on the domestic wastewater dumped off-shore through outfalls. The offshore system would have to be hundreds or thousands of acres in coastal areas to accommodate the amount of wastewater and to make enough fuel to be worthwhile. Such a system would require overcoming significant challenges inherent in large-scale algae cultivation as well as the challenges presented by the coastal marine environment itself. The marine environment challenges engineers to design systems able to cope with strong and variable forces from waves, currents, and winds. It also requires ingenuity in developing materials that can withstand these strong forces along with corrosion, weathering, and biofouling. In some places there are also formidable social challenges in the rules and regulations imposed on developments in coastal regions such as permits and permission from the many coastal regulatory organizations that monitor and control use and environmental impact.

#### Ocean-based production is bad—no room and damage to environment.

FAO 9 [Food and Agriculture Organization of the United Nations May 2009 http://www.fao.org/fileadmin/templates/aquaticbiofuels/docs/0905\_FAO\_Review\_Paper\_on\_Algae-based\_Biofuels.pdf](file:///C:\Users\Real%20Debate\Documents\Food%20and%20Agriculture%20Organization%20of%20the%20United%20Nations%20%20%20May%202009%20http:\www.fao.org\fileadmin\templates\aquaticbiofuels\docs\0905_FAO_Review_Paper_on_Algae-based_Biofuels.pdf) “ALGAE-BASED BIOFUELS: A Review of Challenges and Opportunities for Developing Countries”

Much of the spatial area at sea has existing uses, for example for nature, shipping, fishery, recreation, military training grounds and offshore infrastructure. (Florentinus et al., 2008). Finding cultivation space that has not been claimed for other uses may prove difficult. Conflicts may arise from changing existing use to seaweed production. Another important aspect to be mentioned is the potential damage to ecological or species balance in the ocean, when algae is mass cultivated in parts of the ocean where they were previously not present in large populations, along with the potential decline in oxygen concentration in the water at night which might kill other species. Further, the design of sea-based cultivation systems has to guarantee the prevention of sea mammals and other wildlife getting entangled in it (Florentinus et al., 2008; Reith et al., 2005).

### Solvency – AT Bioreactors

#### Algae biofuels are uneconomical – bioreactors are won’t solve

Melinda Wenner, 5/1/2009, Scientific American, “the next generation of biofuels,” <http://www.scientificamerican.com/article/the-next-generation-of-biofuels/?print=true>

The concept of algae-based fuel is not exactly new, and it’s fraught with problems. In 1978 the DOE began trying to make biodiesel from algae, but the program ended 18 years later after the government concluded the concept wasn’t economically feasible. Algae and cyanobacteria are complicated critters: although they can grow in open ponds, unwanted microbial strains can easily contaminate the water and interfere with the growth of the fuel-making strains. Venter’s alternative is to grow algae in transparent, outdoor vessels called photobioreactors, but these containers are expensive to build and maintain. They must also be constructed so that the right amount of sunlight hits them—too much or too little slows growth. What is more, harvesting the microbes and sucking out the stored fats requires environmentally unfriendly solvents, and new organisms have to be grown to replace the harvested ones.

#### Bioreactors can’t be commercialized

Michael Hannon et al., 8/8/2011, National Institutes of Health, “biofuels from algae: challenges and potential,” <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3152439/>

Improved engineering will make a significant impact on algae biofuel production. These improvements include efficient strategies for nutrient circulation and light exposure, and have been reviewed elsewhere [27,28]. In brief, there are significant challenges for engineers to either design photobioreactors (PBRs) that are cheap enough for large-scale deployment, or for engineers and biologists to combine forces to develop species that grow efficiently in low-cost open systems [29]. PBRs have advantages over open systems in that they can more easily maintain axenic cultures, and can maintain more controlled growth environments, which may lead to increases in productivity; however, contained systems are challenged by efficiencies in gas exchange and a requirement for supplemental cooling [28]. Despite the advantages of decreased contamination and increased productivity, it is unclear whether PBRs will ever become cost competitive with open pond systems. Regardless of the growth strategy employed, substantial improvements over current technologies for the growth, harvesting and extracting oil from algae need to be made, and coordinated efforts will be needed to couple engineering advances with improved production strain.

#### Photobioreactors aren’t reliable – numerous problems prevent solvency

Bruton et al. 9 “A review of the Potential of Marine Algae as a Source of Biofuel in Ireland.” Feb 2009 Tom Bruton (BioXL) Dr Henry Lyons (Shannon Applied Biotechnology Centre) Dr Yannick Lerat (European Research Centre for Algae, CEVA) Dr Michele Stanley (Scottish Association for Marine Science, SAMS) Michael Bo Rasmussen (National Environmental Research Institute, NERI)

<http://www.seai.ie/Publications/Renewables_Publications_/Bioenergy/Algaereport.pdf>

The other commonly encountered system to grow microalgae is known as a closed photobioreactor (often abbreviated to PBR). Algae are also cultivated in suspension, but the system is closed. Water is circulated by pumps. In existing commercial applications, artificial light and sometimes heat is used. For energy or biofuel purposes, only natural light and sometimes waste heat are being considered. Nutrient and gas levels are monitored continuously and adjusted. Page 27 / 88 Closed photobioreactors have the advantages of high productivity, low contamination, efficient CO2 capture, continuous runs, and controlled growth conditions. The major drawbacks are the high capital and operating costs. An example of a photobioreactor design, installed as a pilot at Massachusetts Institute of Technology is shown in Figure 16. There are many design and operational challenges which need to be resolved before low-cost microalgae production using PBR’s can be considered. Some of the design challenges are considered here, but many systems are being trialled worldwide. Fouling and cleaning of any system of both external and internal walls is a problem. Over time accumulation of dirt (external) or algae (internal) will prevent light from penetrating the PBR. Mixing to ensure optimum photosynthetic efficiency is a challenge. In order to maintain turbulent flow, energy needs to be supplied, generally for pumping, or for sparging with gases. Any parasitic energy load must be minimised in order to keep a positive energy balance on the overall process. Equally the embodied energy used in e.g. steel, glass, plastics and other system components must be considered. The morphology of the PBR, its orientation and in particular the depth of the substrate are key considerations, in order to allow sufficient light to penetrate the PBR. Poor design can restrict light access and reduce areal productivity, but equally algae suffer photoinhibition through over-exposure to sunlight. Systems must be designed to allow efficient mixing of CO2 and other nutrients. Indeed PBR design may not be a “one-size-fits-all” approach, as different microalgae species will thrive in different systems and be subjected to different climatic conditions.

#### Cost, technical issues, and sheer number of bioreactors needed kill solvency

Benemann 8 “OPPORTUNITIES AND CHALLENGES IN ALGAE BIOFUELS PRODUCTION,” Dr. John R. Benemann. 2008. (http://www.fao.org/uploads/media/algae\_positionpaper.pdf)

Microalgae cultivation using sunlight energy can be carried out in open or covered ponds ¶ or closed photobioreactors, based on tubular, flat plate or other designs. Closed systems ¶ are much more expensive than ponds, and present significant operating challenges ¶ (overheating, fouling), and due to gas exchange limitations, among others, cannot be ¶ scaled-up much beyond about a hundred square meters for an individual growth unit. ¶ For large-scale biofuels production, which would require systems of ¶ hundreds of hectares in scale, this would mean require deploying tens ¶ of thousands such repeating units, at great capital and operating cost. ¶ Open ponds, specifically mixed raceway ponds (Figure 2B) are much ¶ cheaper to build and operate, can be scaled up to several hectares ¶ for individual ponds and are the method of choice for commercial ¶ microalgae production. However, such open ponds also suffer from ¶ various limitations, including more rapid (than closed systems) biological ¶ invasions by other algae, algae grazers, fungi and amoeba, etc., and ¶ temperature limitations in colder or hot humid climates.

#### Their evidence is based on controlled environments, won’t hold up in practice, and PBRs are inefficient

Jegathese and Farid 14 (Simon Jegan Porphy Jegathese and Mohammed Farid, Department of Chemical and Materials Engineering, The University of Auckland, “Microalgae as a Renewable Source of Energy: A Niche Opportunity” Journal of Renewable Energy, April 24, 2014)

Biomass growth rates determined in laboratory studies are often expressed on per unit volume basis. However, the more appropriate reporting metric is growth per unit area, where area is that exposed to light. Therefore, in order to translate volumetric growth rates (typically from under artificial light conditions) into meaningful, real growth rates (typically under natural light), this requires knowledge of the area exposed to light and the hours per day that light was applied. There is a multitude of additional problems associated with making such translations. Most of the studies upon which volumetric growth rates are based are conducted indoors or at bench-scale and under tightly controlled steady-state conditions, none of which are likely to be applicable to mass production systems. An effective culture system should consist of the following criteria: (1) effective illumination area, (2) optimal gas-liquid transfer, (3) easy to operate, (4) low contamination level, (5) low capital and production cost, and (6) minimal land area requirement. The main advantage of growing microalgae in a closed photobioreactor is that it permits single strain culture in which optimum growth condition is always maintained to give high consistency in biomass and lipid productivity. Thus, closed photobioreactor has always attracted great interest from researches to further improve the operating conditions for implementation in commercial scale.¶ LCA studies done on the energy needed for mass cultivation of microalgae on raceway ponds and photobioreactors indicated a rather unexpected result; raceway ponds emerged as a more sustainable and economic way to culture microalgae even though optimum culture conditions (microalgae with high lipid productivity) are achieved in air-lift tubular photobioreactor. The average energy input to operate air-lift photobioreactor is around 350% higher compared to raceway pond [37, 38]. Despite the advantages of lower level of contamination and optimal use of cultivation area, since CO2 is soluble in water relative to oxygen, the air-lift tubular photo-bioreactor consumed significant amount of power in order to obtain optimum mixing and gas-liquid mass transfer so that required mixing and optimum gas-liquid transfer rate are achieved. Based on currently available technology, air-lift photobioreactor is not up to commercialization stage unless proper modifications are performed to reduce the overall operating energy consumption. One of the plausible improvements that can be done is by designing an oscillatory flow reactor rather than a tubular type [37]. Oscillatory flow reactor consists of equally spaced orifice plate baffles in which the baffles behave like stirred tanks that can give excellent mixing effect by creating vortices between orifice baffles and superimposed oscillating fluid; then, energy consumption can be reduced because only minimal culture velocity is required to achieve intense mixing effect [57]. In addition, mass transfer of CO2 to culture medium can be further improved and enhances CO2 utilization by microalgae.

#### Photobioreactors have weak plastic and are expensive

NYT 9 http://www.nytimes.com/gwire/2009/05/12/12greenwire-nasa-bags-algae-wastewater-in-bid-for-aviation-12208.html May 12 2009

Trent and his fellow researchers are still trying to find plastic capable of withstanding pounding waves and cold temperatures without becoming too brittle for osmosis.¶ And then there is the matter of money. Venture capitalists are wary, Trent said, but his team has had some luck with the California Energy Commission. A state grant is slated to kick in this August.¶ The grant should help Trent and the other Ames researchers create a demonstration project within a year. That would let the technology get wider scrutiny and be compared with other renewable-energy technologies.¶ "On a planet with a population growing at exponential rates and resources dwindling, we're almost in a state of emergency on a timeline measured in decades," Trent said. "I think it's important, this process of coming up with alternatives. ... I don't know if OMEGA is the solution, but it's something that should be carefully scrutinized."

#### PBR’s have issues with toxicity levels, cell damage, and insufficient levels of light

Falinski 9 Kim Falinski completed her B.S. in Electrical Science and Engineering at Massachusetts Institute of Technology in 2002. “EFFECTS OF DIFFERENT AERATION CONDITIONS ON ISOCHRYSIS GALBANA (T-ISO) CCMP 1324 IN A BENCH-SCALE PHOTOBIOREACTOR ” http://dspace.library.cornell.edu/bitstream/1813/13466/1/Falinski,%20Kim.pdf

The most pressing issues in large-scale photobioreactor design involve how to maintain sufficient levels of mixing to maximize light-dark cycling and light availability, prevent cells from settling, prevent dissolved oxygen build-up above toxic levels, and disperse heat without damaging temperature-sensitive algae cells (Gudin, 1991; Tredici, 1999, p. 21; Molina-Grima et al., 2000; Acien-Fernandez, 2001; Chisti, 2007). Mixing also minimizes gradients in temperature and nutrients and increases gas and light transfer. Light-dark mixing frequencies on the order of seconds have been found, experimentally, to be necessary for optimal biomass production and growth rates (Lee and Pirt, 1981; Grobelaar, 1989; Janssen, 2003; Park, 2001). The process has also been modeled by researchers to understand further the influence of mixing on cell growth rate (Acien-Fernandez et al., 1997; Wu and Merchuk, 2001). Results indicate that increased mixing by aeration contributes positively to cell growth. Shearing action in sparged photobioreactors is a necessary byproduct of mixing. Cell damage resulting from shear stress has been referred to as the key problem to be reduced if photobioreactors are to be successfully used for culturing microalgae (Gudin, 1991; Pulz, 2001). Although the growth rates of many microalgae have been shown to increase initially with increased aeration due to the improved supply of CO2 and more frequent access to light, shear damage due to aeration has been shown for many species to result in reduced cell production (Silva et al., 1987; Contreras et al., 1998; Chisti, 1999; Barbosa, 2003b).

### Solvency – AT Bioreactors (OMEGA specific)

#### OMEGA bioreactors can’t withstand environmental pressures

Katie Howell, 5/12/2009, New York Times, “NASA bags algae, wastewater in bid for aviation fuel,” <http://www.nytimes.com/gwire/2009/05/12/12greenwire-nasa-bags-algae-wastewater-in-bid-for-aviation-12208.html>

But the technology faces challenges.¶ Trent and his fellow researchers are still trying to find plastic capable of withstanding pounding waves and cold temperatures without becoming too brittle for osmosis.¶ And then there is the matter of money. Venture capitalists are wary, Trent said, but his team has had some luck with the California Energy Commission. A state grant is slated to kick in this August.¶ The grant should help Trent and the other Ames researchers create a demonstration project within a year. That would let the technology get wider scrutiny and be compared with other renewable-energy technologies.¶ "On a planet with a population growing at exponential rates and resources dwindling, we're almost in a state of emergency on a timeline measured in decades," Trent said. "I think it's important, this process of coming up with alternatives. ... I don't know if OMEGA is the solution, but it's something that should be carefully scrutinized."

#### OMEGA bioreactors will fail - biofouling

Trent, Jonathan. (NASA Ames Research Center). 2012. OMEGA (Offshore Membrane Enclosurs for Growing Algae) ‐ A Feasibility Study for Wastewater to Biofuels. California Energy

Commission. Publication number: CEC‐500‐2013‐143.

One of the most significant challenges for a successful OMEGA system deployed in the marine ¶ environment will be biofouling caused by marine organisms colonizing the outside of PBRs that ¶ will influence buoyancy, drag, and potentially light availability for microalgae cultured inside ¶ the PBRs. Two floating PBR designs (flat-panel and tubular) were deployed to study the rates of ¶ biofouling and to determine the impact of external biofouling on internal algae growth at a field ¶ site in Moss Landing Harbor, Moss Landing, CA

### Solvency - AT Modeling

#### Algae biofuels can’t spread globally – developing countries can’t adopt it

Lee et. al 14 (Aston Lee1¶ , Debra Tong1¶ , Mameegate Zheng Jun Cheston1¶ , Zack Ho Xuan Yi1, Rajee Olaganathan2, ¶ Is Biofuel a Feasible Long-Term Chief Energy ¶ Source? a Global Perspective, International Journal of Innovative Research in Science, ¶ Engineering and Technology ¶ Vol. 3, Issue 6, June 2014¶ <http://www.ijirset.com/upload/2014/june/10_IsBiofuel.pdf>) PS

Judging the varying levels of agricultural limitations of both previous generations, third generation biofuel eliminates ¶ harm done to agricultural land because they are solely generated from lipid in algae, also known as “Algal Biofuel”. ¶ The diversity in which algae can be cultivated, in open ponds, closed-loop systems or photobioreactors, deems it an ¶ extremely feasible alternative. Furthermore, it is believed that no other crop can match up to algae’s product quality or ¶ diversity. For example, not only is algae capable of producing shockingly high yields of up to 20 times that of first and ¶ second generations, it can be “genetically manipulated”[10] to produce types of biofuel from all generations. Algae can ¶ also directly convert carbon emissions from industrial plants to usable fuel, reducing air pollution. Thus, algae is said to ¶ be efficient. However, as with any other situation, there is a downside to algae biofuel. In order to support rapid ¶ growth, a substantial amount of water, nitrogen and phosphorus must be present. With large-scale cultivation, comes the ¶ need for mass fertilizer production, resulting in colossal greenhouse gas emissions. Hence, the initial benefits of algae ¶ biofuel are neutralized. This costly option would also be unsuitable for developing countries facing water shortages. ¶ Furthermore, the algae’s lipid is known to be “highly unsaturated” [10]and can degrade at higher temperatures, affecting ¶ automobile engines in the long term. As such, the possibility of third generation biofuel being made commercial is still ¶ highly unlikely.

## Algae Biofuel Production Bad

### Invasive Species Turn

#### Algae will escape the enclosures – this pollutes the environment and causes endocrine disruption

CATF 13 (The Status of Algal Biofuel Development, Clean Air Task Force, 2013, <http://www.catf.us/resources/whitepapers/files/201307-CATF%20Status%20of%20Algal%20Biofuels.pdf>)PS

Researchers seem to accept that algae in open pond systems – and even those in enclosed systems – will almost certainly escape into the larger environment, even with strict regulations in place (Henley et al., 2012; Handler et al., 2012; Slade & Bauen, 2013). The subsequent impacts are unknown, though competition would likely benefit wild algae over their domesticated or genetically modified counterparts (Henley et al., 2012). Wild algae, for instance, have evolved light harvesting antennae larger than is efficient in order to shade out competitors (Perrine, Negi & Sayre, 2012). Consequently, photosynthetic losses are high. Perrine et al. (2012) demonstrate in the lab that, while wild algae can lose up to¶ 75% of the energy they absorb to heat or fluorescence, green algae with transgenically- modified antennae size can double photosynthetic efficiency and enhance the organism’s growth by 30%. This study may have important implications for algal biofuel production, while also highlighting one competitive disadvantage of modified algae for biofuel when compared to those in the wild.¶ Ecosystems could still be affected, however, to a greater or lesser extent than they currently are when exposed to algal blooms and eutrophication. These pose dangers to society, including the risk of contact with toxins that can lead to endocrine disruption and liver failure in humans (Menetrez, 2012). Conversely, little research has been conducted on the threats to farmed algae from pathogens like bacteria and viruses (Georgianna & Mayfield, 2012). Researchers further caution that algae are capable of horizontal gene transfer6 with other algae as well as occasionally with beings higher up the chain, such as phytoplankton (Henley et al., 2012) and sea slugs (Snow & Smith, 2012). The potential for horizontal gene transfer complicates the process of modifying existing algal species.

#### Endocrine disruption causes extinction

Lisbeth Prifogle, 5/7/2012, Hormones Matter, "evolution or extinction of men," <http://www.hormonesmatter.com/endocrine-disruptors-mens-health/>

While researching this topic, I came across one statistic that stated, “1 in 6 couples is infertile.” Low sperm count is another one of the many results of endocrine disruptors in our environment. A study released by the Denmark government concluded that “young men are less fertile than their fathers and produce only a third as much semen, proportionately, as hamsters.” In another study, there is evidence that the birth rate of boys is decreasing in industrial nations including Japan, US, Canada, Denmark and other European nations. And yet, in another report, evidence that men exposed to high levels of phthalates actually damaged the DNA of their sperm. Is the 2006, post-apocalyptic film, Children of Men, which takes place in a not-so-far-off future where mankind is no longer able to reproduce, just fiction or a warning tale? As we fight for women’s right to control reproduction, maybe we should also be fighting for the right to reproduce as well!

### Algae Biofuels Bad – Hurts the Environment

#### Algae biofuels are toxic and harm biodiversity

Menetrez 12 “An Overview of Algae Biofuel Production and Potential Environmental Impact,” Marc Y. Menetrez. 2012. (http://tamuweb.tamu.edu/faculty/tpd8/BICH407/es300917r.pdf)

The biofuel production industry is composed of many¶ companies, each of which has adopted its own process and, for¶ many, its own GMO form of algae. Each proprietary process¶ design, and the reagents used (e.g., microorganisms, enzymes,¶ chemicals), will determine the quantity and nature of waste¶ produced. The various biological processes will amplify the¶ microbial populations (including GMO varieties), algae, toxins,¶ and enzymes that may be potentially hazardous to the¶ environment and individuals. Each process could contain¶ constituents that are potentially pathogenic, toxic, infective, or¶ allergenic and that are of concern for aﬀecting native microbial¶ populations and, consequently, ecosystem balance. It is unclear¶ what the impacts of release of these materials might be, but¶ without a more complete understanding of the composition¶ and amounts produced by the various processes, it is impossible¶ to adequately estimate the risk associated with these materials.¶ Potential human and environmental risks exist in association¶ with the numerous forms of GMO algae that are being¶ developed for biofuel generation. The various risks are¶ toxigenicity (from known and unknown GMO toxins),¶ allergenic responses (from proteins and organic and inorganic¶ chemicals), and unknown environmental eﬀects that could¶ potentially cause the unintended transfer of transgenes or cause¶ the loss of ﬂora and fauna biodiversity. An evaluation¶ methodology is needed to better understand the GMO eﬀects¶ and their associated risks to the environment.

#### Algae cultivation hurts biodiversity

Menetrez 12 “An Overview of Algae Biofuel Production and Potential Environmental Impact,” Marc Y. Menetrez. 2012. (http://tamuweb.tamu.edu/faculty/tpd8/BICH407/es300917r.pdf)

16. Toxicological Impacts. Algae populations can be¶ affected by increased waterborne nutrient load caused by¶ farming, growing populations, land use development, and¶ trends causing increased environmental stress to wetlands and¶ marshes. Freshwater algae, marine algae, and cyanobacteria all¶ produce toxins. These toxins can induce dermatitis, neurological¶ disruptions, and hepatotoxicity or liver failure.46,97,98¶ Anthropogenic factors such as point and nonpoint source¶ discharges into waterways can cause increased nutrient levels in¶ marine and limnic environments triggering algae blooms and¶ negatively impacting biodiversity with increased toxins and¶ decreased dissolved oxygen levels.97,99−101 Commonly referred to as fish kills, the effects can be widespread and environmentally¶ detrimental. Increased incidents of toxic algae are¶ being documented in more localities and at greater frequency¶ and magnitude.

#### Algae biofuel production causes uncontrollable mass dieoffs of animals and humans

Menetrez 12 “An Overview of Algae Biofuel Production and Potential Environmental Impact,” Marc Y. Menetrez. 2012. (http://tamuweb.tamu.edu/faculty/tpd8/BICH407/es300917r.pdf)

Marine microalgae can cause many human illnesses linked to¶ the consumption of seafood and the inhalation of contaminated¶ aerosolized toxins. They have also been responsible for the¶ massive die-off of fish, shellfish, and marine vertebrates, as well¶ as the corresponding mortality in seabirds, marine mammals,¶ and other animals.104 Marine microalgae produce toxins that¶ cause 60 000 human intoxications (a physiological state of¶ impairment) per year worldwide, with a mortality rate of 1.5%¶ (or 900 fatalities).104 Most fatalities are caused by ingestion of¶ seafood containing saxitoxins, tetrodotoxins, and in rare cases,¶ ciguatera and domoic acid.71,105−107 Only acute intoxications¶ have been studied for their toxicological or medical effects,¶ while chronic or low-concentration exposures have¶ not.71,105−107¶ Marine toxins are produced by two algal groups, dinoflagellates¶ and diatoms. Of the 3000 species of dinoflagellates¶ and diatoms, approximately 2%, or 60−80 species, are known¶ to be toxic.71,105−108 The majority of these toxins are¶ temperature-stable neurotoxins, which eliminates cooking as a¶ control measure.¶ In addition to human intoxications, marine toxins cause¶ deaths to other forms of marine life and wildlife that are¶ dependent on the aquatic food chain. Marine biotoxins, such as¶ diatoms and red algae (Chondria spp.), are routinely monitored¶ for toxins, including paralytic, neurotoxic, diarrhetic, and¶ amnesic shellfish toxins, as well as compounds such as¶ yessotoxins, specifically pectenotoxin and gymnodimine.¶ Monitoring of algae blooms and other harmful algae is¶ constantly reviewed in the light of new research that¶ incorporates local knowledge of oceanographic and climatic¶ conditions. Increased awareness, monitoring, surveillance, and¶ identification of toxic algae blooms are the only means of¶ control or avoidance.109−112

#### Algae biofuels are toxic and harm biodiversity

GCC, 6/22/2012, Green Car Congress, “EPA research calls for development of evaluation methodologies and tools to understand positive and negative impacts of algae industry,” <http://www.greencarcongress.com/2012/06/menetrez-20120622.html>

The biofuel production industry is composed of many¶ companies, each of which has adopted its own process and, for¶ many, its own GMO form of algae. Each proprietary process¶ design, and the reagents used (e.g., microorganisms, enzymes,¶ chemicals), will determine the quantity and nature of waste¶ produced. The various biological processes will amplify the¶ microbial populations (including GMO varieties), algae, toxins,¶ and enzymes that may be potentially hazardous to the¶ environment and individuals. Each process could contain¶ constituents that are potentially pathogenic, toxic, infective, or¶ allergenic and that are of concern for aﬀecting native microbial¶ populations and, consequently, ecosystem balance. It is unclear¶ what the impacts of release of these materials might be, but¶ without a more complete understanding of the composition¶ and amounts produced by the various processes, it is impossible¶ to adequately estimate the risk associated with these materials.¶ Potential human and environmental risks exist in association¶ with the numerous forms of GMO algae that are being¶ developed for biofuel generation. The various risks are¶ toxigenicity (from known and unknown GMO toxins),¶ allergenic responses (from proteins and organic and inorganic¶ chemicals), and unknown environmental eﬀects that could¶ potentially cause the unintended transfer of transgenes or cause¶ the loss of ﬂora and fauna biodiversity. An evaluation¶ methodology is needed to better understand the GMO eﬀects¶ and their associated risks to the environment.

#### Algae cultivation hurts biodiversity

Menetrez 12 “An Overview of Algae Biofuel Production and Potential Environmental Impact,” Marc Y. Menetrez. 2012. (http://tamuweb.tamu.edu/faculty/tpd8/BICH407/es300917r.pdf)

16. Toxicological Impacts. Algae populations can be¶ affected by increased waterborne nutrient load caused by¶ farming, growing populations, land use development, and¶ trends causing increased environmental stress to wetlands and¶ marshes. Freshwater algae, marine algae, and cyanobacteria all¶ produce toxins. These toxins can induce dermatitis, neurological¶ disruptions, and hepatotoxicity or liver failure.46,97,98¶ Anthropogenic factors such as point and nonpoint source¶ discharges into waterways can cause increased nutrient levels in¶ marine and limnic environments triggering algae blooms and¶ negatively impacting biodiversity with increased toxins and¶ decreased dissolved oxygen levels.97,99−101 Commonly referred to as fish kills, the effects can be widespread and environmentally¶ detrimental. Increased incidents of toxic algae are¶ being documented in more localities and at greater frequency¶ and magnitude.

#### Turn: Algae blocks sunlight from other vegetation, harming ecosystems

Katz 10 (Diane Katz, Research Fellow in Regulatory Policy at the Heritage Foundation, “The Nation’s River Reveals Nature’s Resilience,” the Heritage Foundation, 9/13/2010 http://dailysignal.com/2010/09/13/the-nations-river-reveals-nature%E2%80%99s-resilience/)

Decades of discharges from government-run wastewater treatment plants—particularly Washington, D.C.’s Blue Plains facility—loaded the Potomac with nitrogen and other nutrients that nurtured colonies of algae. In conjunction with sediment from runoff, the algae clouded the water and blocked sunlight from reaching riverbed vegetation—the source of oxygen, food, and shelter for invertebrates, fish, and waterfowl. A dark emptiness thus descended, prompting President Lyndon B. Johnson to declare the river “a national disgrace,” according to The Washington Post.

#### Algae blooms cause a wreck of environmental destruction

Giersbergen, 14

(Jos van Giersbergen, Jos graduated as an engineer and reports on new and green technology, From Quarks to Quasars, “A Truly Green Revolution: Turning Algae into Biofuel,” January 22, 2014 http://www.fromquarkstoquasars.com/a-truly-green-revolution-turning-algae-into-biofuel/)

Some types of algae are more efficient than others. When pinpointing one specific thing, the lipid content seems the largest contributing factor. Depending on the content, a kilo will either power an SUV or mow a small lawn. Unfortunately, the most effective forms of algae are also the most exotic species of algae, and those generally don’t multiply fast enough to suit our purposes. Plus, algae is wet, very wet. So wet, in fact, that the only real way to use it as a viable source of energy is to dry it out… at massive costs. Growing them and drying them in large enough quantities is proving to be a major hurdle. To provide the U.S. with enough algae to support their daily appetite, it would require an amount of algae equal in surface area to the state of Maryland; however, that’s still ten times smaller than what would be needed for providing enough biodiesel from corn or soy; that would have to be half the landarea of the U.S.A. Additionally, even if we were able to grow that much algae in order to meet out needs, it would be problematic as Algae blooms are quite destructive. They can literally choke the life from a region; however, most worrying are the toxic species. If it becomes profitable to tinker with the genome of one of those, a corporate sense of ethics might be all that stands between us and environmental pandemonium. So algae blooms are no joke. Even if the species involved is not toxic (and most of them are not), they can still do plenty of harm. Simply blocking sunlight will stifle the growth of, or even kill, the marine flora (which forms the basis of many underwater food chains). At night, algae will use more oxygen than they produce (no photosynthesis). Compounding that is the fact that, as algae die and decompose, they use up even more oxygen. In short, the day that there is an algae bloom is not a good day to be a fish. In addition, to turn algae into oil, you have to be able to grow enough of them to begin with, and most studies show that contamination with other organics would severely limit productivity.

### Algae Biofuels Bad – Escape Containment/Hurt Ecosystems/Invasive Species

#### Algae aquacultures risk damage from invasive species and damage ecosystems

McGraw 9 (Lindsay McGraw ¶ , The Ethics of Adoption and Development of ¶ Algae-based Biofuels, UNESCO, 2009, ¶ http://www.dienst-regelingen.nl/sites/default/files/bijlagen/Ethics\_of\_Adoption\_and\_Development\_of\_Algae-based\_Biofuels.pdf ) PS

Microalgae, both in natural habitats and in aquaculture are often plagued by harmful ¶ contaminants such as viruses, bacteria, protists, fungi, and various grazers. Of greater ¶ concern, however is the possibility that the algae itself becomes an invasive species ¶ within natural ecosystems. Precautions should be taken to prevent contamination of ¶ natural environments with algal species that may be more robust and possibly creating ¶ blooms that quash aquatic communities.

# Biofuels Advantage

## Biofuels Solvency

### Algae Biofuels – Not Feasible

#### Algae biofuel tech is not feasible – too many hurdles

Hannon et al, 10

(Michael Hannon, Javier Gimpel, Miller Tran, Beth Rasala, and Stephen Mayfield, National Institute of Health, “Biofuels from algae: challenges and potential,” September 2010, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3152439/)

Algae biofuels may provide a viable alternative to fossil fuels; however, this technology must overcome a number of hurdles before it can compete in the fuel market and be broadly deployed. These challenges include strain identification and improvement, both in terms of oil productivity and crop protection, nutrient and resource allocation and use, and the production of co-products to improve the economics of the entire system. Although there is much excitement about the potential of algae biofuels, much work is still required in the field. In this article, we attempt to elucidate the major challenges to economic algal biofuels at scale, and improve the focus of the scientific community to address these challenges and move algal biofuels from promise to reality.

#### Algae biofuels create poor fuel—this dooms commercialization

Sawahel 10 “Biofuels from algae plagued with problems, says review,” Wagdy Sawahel. 07/05/10. (http://www.scidev.net/global/biofuels/news/biofuels-from-algae-plagued-with-problems-says-review-1.html)

Hopes that algae could become a source of biodiesel that is friendly both to the environment and the poor may be premature, according to a review. ¶ When early sources of biofuels — mostly derived from food crops — incurred widespread criticism for being harmful to the environment, undermining food security, and being unlikely to reduce overall carbon emissions, algae emerged as a potential biofuel source that could sidestep these problems.¶ But they have serious drawbacks that may mean they can never compete with other fuels, according to Gerhard Knothe, a research chemist with the US Department of Agriculture's Agricultural Research Service.¶ "One aspect that has received little to no attention in the rush to develop fuels from algae is fuel properties," said Knothe. "Will the properties of fuels ultimately derived from algae be competitive with the properties of existing fuels or biofuels?¶ "Unfortunately, there are virtually no literature reports on the properties of algae-derived biodiesel."¶ When researching his paper, 'Production and Properties of Biodiesel from Algal Oils' which will be published by Springer in a book, currently in press, entitled Algae for Biofuels and Energy, he made "unexpected" findings, he said.¶ Knothe found that "many, if not most" of the biodiesel fuels derived from algae have "significant problems" when it comes to their ability to flow well at lower temperatures ('cold flow') and they also degrade more easily than other biofuels.¶ This is because many algal oils — from which the biodiesels are derived — contain relatively high amounts of saturated and polyunsaturated fatty acids. Knothe said that researchers have been focusing on improving only the production of algae and fuels, but the need to investigate the fuel properties is now "urgent". ¶ "The best production method may ultimately not accomplish much if the fuel is not competitive in terms of properties," he told SciDev.Net.¶ Luiz Pereira Ramos, chemist at the Federal University of Parana, Brazil, said Knothe was "absolutely correct. Most of the algae-derived biodiesel investigated to date are not suitable for fuel use." ¶ The principal hope for overcoming the problem, both scientists said, is through genetic engineering of algae so they yield oils with more useful properties. ¶ "However, this reality is still far away from anything practical," said Ramos.

#### Can’t overcome logistic problems in growth of algae

Wagner 7 “Biodiesel from Algae Oil,” Leonard Wagner. July 2007. (http://www.fao.org/uploads/media/0707\_Wagner\_-\_Biodiesel\_from\_algae\_oil.pdf)

Challenges in Algaculture ¶ According to an article published in May 2007 by the Nature magazine [19], Algae can also be picky: ¶ ¶ too much direct sunlight can kill them, ¶ temperature must be held steady, ¶ overcrowding will inhibit their growth, ¶ the ―waste‖ oxygen they produce must be continually removed from the water, ¶ open algal ponds are subject to evaporation and rainfall, which cause salinity and pH ¶ imbalances, and ¶ local species of algae often overgrow the desired strain.

#### Algae biofuel production causes uncontrollable mass dieoffs of animals and humans

Menetrez 12 “An Overview of Algae Biofuel Production and Potential Environmental Impact,” Marc Y. Menetrez. 2012. (http://tamuweb.tamu.edu/faculty/tpd8/BICH407/es300917r.pdf)

Marine microalgae can cause many human illnesses linked to¶ the consumption of seafood and the inhalation of contaminated¶ aerosolized toxins. They have also been responsible for the¶ massive die-off of fish, shellfish, and marine vertebrates, as well¶ as the corresponding mortality in seabirds, marine mammals,¶ and other animals.104 Marine microalgae produce toxins that¶ cause 60 000 human intoxications (a physiological state of¶ impairment) per year worldwide, with a mortality rate of 1.5%¶ (or 900 fatalities).104 Most fatalities are caused by ingestion of¶ seafood containing saxitoxins, tetrodotoxins, and in rare cases,¶ ciguatera and domoic acid.71,105−107 Only acute intoxications¶ have been studied for their toxicological or medical effects,¶ while chronic or low-concentration exposures have¶ not.71,105−107¶ Marine toxins are produced by two algal groups, dinoflagellates¶ and diatoms. Of the 3000 species of dinoflagellates¶ and diatoms, approximately 2%, or 60−80 species, are known¶ to be toxic.71,105−108 The majority of these toxins are¶ temperature-stable neurotoxins, which eliminates cooking as a¶ control measure.¶ In addition to human intoxications, marine toxins cause¶ deaths to other forms of marine life and wildlife that are¶ dependent on the aquatic food chain. Marine biotoxins, such as¶ diatoms and red algae (Chondria spp.), are routinely monitored¶ for toxins, including paralytic, neurotoxic, diarrhetic, and¶ amnesic shellfish toxins, as well as compounds such as¶ yessotoxins, specifically pectenotoxin and gymnodimine.¶ Monitoring of algae blooms and other harmful algae is¶ constantly reviewed in the light of new research that¶ incorporates local knowledge of oceanographic and climatic¶ conditions. Increased awareness, monitoring, surveillance, and¶ identification of toxic algae blooms are the only means of¶ control or avoidance.109−112.

#### No investment— outrageous cost, unreliable output, more research needed

Benemann 8 “OPPORTUNITIES AND CHALLENGES IN ALGAE BIOFUELS PRODUCTION,” Dr. John R. Benemann. 2008. (http://www.fao.org/uploads/media/algae\_positionpaper.pdf)

¶ The critical issue, after technical feasibility, that is the actual ability to ¶ reliably cultivate algal strains that can produce oil at reasonably high ¶ productivities, is the overall capital and operating cost of these production ¶ systems. Currently the plant gate production cost (e.g. not including ¶ costs such as marketing) for the lowest cost algal biomass produced ¶ for the nutritional market, Spirulina can be estimated at about $5,000 per ¶ metric ton. Although this alga does not make oil, and has relatively low ¶ productivity, assuming that oil containing algae could be produced for a similar cost, and that the algal ¶ biomass had content of 25% oil, this would translate to $20,000/ton of oil, or over 20-fold higher than current vegetable or crude oil prices. ¶ Of course it can be rightly argued that current commercial ¶ algae production is very small scale and inefficient, and that the ¶ economies of scale possible for biofuel production, as well as foreseeable advances in the technology, ¶ could reasonably overcome this gap. Even assuming that high biomass and oil productivities are ¶ possible and stable cultivation achievable, the major problem is likely the irreducible minimal costs ¶ of large-scale cultivation systems, including the needed infrastructure, processing, waste treatment, ¶ water supply and other support systems required. ¶ Prior economic-engineering feasibility analyses have conclude that even the simplest open pond ¶ systems, including harvesting and algal biomass processing equipment, would cost at least $100,000 ¶ per hectare, and possibly significantly more. To this would need to be added operating costs. And ¶ algae production requires a site with favorable climate, available water (which can be saline, brackish ¶ or wastewater), a ready and essentially free source of CO2¶ , nearly flat land, and with a clay soil or ¶ liner, as plastic liners would be too expensive. ¶ In brief, this represents the current reality, opportunity and challenges of microalgae oil and biofuels ¶ production. Because of the very high costs of closed photobioreactors, these would not be applicable ¶ to algal oil production, asides their above discussed use in seed production. In any event, development ¶ of this technology will require long-term, high risk, R&D.

#### Algae growth on a wide scale is infeasible – costs, water supply, temperature, and pollution risks

Rimal 14 (Bigyan Rimal, UNESCO Fellow at AGH University of Science and Technology in the Department of Environmental Biotechnology and Ecology, “GREEN SCUM TO GREEN ENERGY – PROSPECTS AND CHALLENGES” Student Energy, March 12 2014, http://studentenergy.org/blog/green-scum-to-green-energy-prospects-and-challenges/)

With all these possibilities and achievements it seems microalgae are the best alternative source for energy production. If so, why are not we fuelling our vehicles with algal oil or gas?¶ Micro algae growth is as challenging as it is promising. Growth of micro algae primarily depends on sunlight intensity and availability, nutrient source, carbondioxide level, temperature and the system of cultivation. Though the idea looks perfect, when it comes to optimising all these parameters the problem becomes colossal. Because of huge capital costs, not a single micro algae commercial-scale production system for energy production exists. Selection of location with proper sunlight exposure is very important. Sometimes higher exposure to sun can reduce the growth of algae – the photo inhibition effect. Locations with insolation not less than 3000hr/yr are supposed to be good. The water supply is another challenge. Low cost and regular supply of appropriate water is very important for algae cultivation. An advantage is waste water or sea water can also be used, but the risk of increasing inhibiting factors is always high and pre-treatment increases the cost of cultivation. Nitrogen, Phosphorus and Potassium are the major nutrients required for micro algae cultivation. A dried mass of micro algae contains approximately 7% of Nitrogen and 1% of Phosphorus. The nitrogen supplement also leads to additional cost. To produce 1 kilo of micro algae biomass, 1.83 kg of CO2 is required. Installation of a CO2 generation unit is a poor choice in terms of the cost and the environmental affect. Therefore, the location must be near a continuous source of CO2. Fossil fuel use cannot be by-passed completely, even though we want to produce electricity fuels from algae. During the time of cultivation, temperature regulation plays an important role in producing optimum yields. The use of natural gas during drying processes also demands expense of it. Chances of soil and water pollution because of Eutrophication of residual nutrients are also high.

#### Takes years to develop tech—if at all

Benemann 8 “OPPORTUNITIES AND CHALLENGES IN ALGAE BIOFUELS PRODUCTION,” Dr. John R. Benemann. 2008. (http://www.fao.org/uploads/media/algae\_positionpaper.pdf)

Even with this advantage, the development of the algal strains and cultivation technologies to the ¶ level of productivity, efficiency, stability, and easy harvesting required for biofuels production will ¶ be very difficult and require years, assuming it proves to be actually feasible at all. Further, such ¶ developments in the “software”, must be combined with the “hardware”, the engineering design of ¶ the production system, including not only the large ponds, larger than anything operated thus far for ¶ intensive commercial cultivation, but also the algal processing, oil extraction, etc. ¶ Again, there is no guarantee that a sufficiently low-cost process can actually be engineered. On ¶ the other hand, there are no clear “show-stoppers” that would suggest that either the biological or engineering R&D required cannot be eventually successful.

### AT Replaces Fossil Fuels

#### Algae biofuels will take a decade to commercialize and can only meet 8% of US demand

Collin Eaton, 12/27/2013, Fuel Fix, “biofuel scientists making headway on cheaper algae-based crude,” <http://fuelfix.com/blog/2013/12/27/biofuel-scientists-making-headway-on-cheaper-algae-based-crude/>

“It’s going to take five to 10 years to get things up to production scale,” he said.¶ In the new process, a chemical reactor can turn algae into crude in less than an hour, and the byproducts from the process have enough phosphorus to grow more algae. Like the crude that oil derricks have pumped for decades, the stuff can then be refined into engine food like gasoline and diesel.¶ The Pacific Northwest National Laboratory said in May that available U.S. land and water resources – especially in the Gulf Coast and other southern regions – could be turned into 25 billion gallons of algae-based fuel a year, about 8 percent of the country’s annual consumption.

#### Algae can never offset fossil fuel consumption

Ken Silverstein, 5/20/2012, Forbes, “will algae biofuels hit the highway?” <http://www.forbes.com/sites/kensilverstein/2012/05/20/will-algae-biofuels-hit-the-highway/2/>

Algae, today, is a blip on the radar. But, tomorrow, it may become a full-scale blimp. According to Pike Research, it could be a 61 million barrels a year commodity with a market value of $1.3 billion by 2020. That’s a compound growth rate of 72 percent, it adds. To put that in context, 83 million barrels of oil are consumed each day around the world. Of that, the United States uses about 18 million a day.¶ “On paper, algae could displace worldwide petroleum use altogether, however, the industry has yet to produce a drop of oil for commercial production,” says Pike Research president Clint Wheelock. “Although the algae-based biofuels market will grow rapidly once key cost hurdles are overcome, widespread scale-up will be hampered by a number of difficult challenges including access to nutrients, water, and private capital.”

#### Algae biofuels are inefficient—31 million tons of algae displaces only 1% of US gas consumption

Christi 13 “Constraints to commercialization of algal fuels,” Yusuf Chisti. 22 July 2013. (http://www.tamu.edu/faculty/tpd8/BICH407/Chisti%202013%20Journal%20of%20Biotechnology.pdf)

Production of algal oil to replace just 1% of the US annual¶ consumption of petroleum will require the production of a vast¶ quantity of algal biomass, approximately 31 million tons at 40% by¶ weight oil in the biomass.¶ Large scale culture technologies for producing algal biomass¶ have been around for decades. Of these, the most commonly¶ used raceway ponds (Terry and Raymond, 1985; Spolaore et al.,¶ 2006; Chisti, 2007, 2012) have an exceedingly low productivity¶ compared to what the algal biology allows. A practical upper¶ limit to algal oil productivity of conventional raceways is about¶ 37,000 L ha−1 year−1 (Chisti, 2012). Whether raceways can be used¶ to produce sufficient algal biomass inexpensively for making biofuels¶ is debatable (Chisti, 2012). Closed culture systems such as¶ photobioreactors (Sánchez Mirón et al., 1999; Molina Grima et al.,¶ 2000; Acién Fernández et al., 2001; Carvalho et al., 2006; Wang¶ et al., 2012) are more productive and can achieve a much higher¶ concentration of algal cells in the water (e.g. 5 kg m−3) than is possible¶ in raceways (e.g. 0.5–1.5 kg m−3), but are expensive and require¶ a lot of energy to operate. A high energy expenditure for producing¶ algal biomass is of course unacceptable (Chisti, 2008b; Sompech¶ et al., 2012; Wongluang et al., 2013), or the net energy recovered¶ in the algal oil will be low (see Section 2.4).¶ Novel biomass production methods that rely on sunlight,¶ achieve high productivity and biomass concentration in the¶ broth, and are inexpensive and energy efficient, are needed. Perhaps¶ shallow raceways, or other low cost systems with a high surface-to-volume ratio to maximize sunlight capture and transmission¶ into the algal broth, may be worth considering. Given a¶ sufficiency of all nutrients, a high density algae culture is attainable¶ only at high light intensities and only in a growth system with¶ a shallow depth (Zijffers et al., 2010). Production processes involving¶ wastewater-filled plastic bags floating in coastal waters, mixed¶ by wave action and dewatered by forward osmosis, have been proposed¶ by Jonathan Trent of the US National Aeronautics and Space¶ Administration (National Aeronautics and Space Administration:¶ www.nasa.gov/centers/ames/research/OMEGA/index.html; Trent¶ et al., 2010, 2012).¶ What can be done to consistently maintain a high productivity¶ during the entire cultivation period at least in regions where¶ sunlight and temperature are essentially invariant with time, is a¶ question yet to be answered for large scale outdoor culture of algae.¶ Productivity can be substantially enhanced not only through engineering¶ of a growth system, but also by addressing issues of algal¶ biology as discussed later in this review.

#### Algae can’t replace fossil fuels – displaces 0.2% of road fuel demand, logistics, and economics

Nesbit 14 (Rebecca Nesbit, press officer at the Society of Biology and Tom Ireland, managing editor of The Biologist, the Society of Biology’s magazine “ALGAL BIOFUELS FULL BLOOM OR DEAD IN THE WATER?” Laboratory News, March 20, 2014 http://www.labnews.co.uk/features/algal-biofuels-full-bloom-or-dead-in-the-water/)

If we are to produce algal biofuel on a sufficient scale for transport fuel, research needs to take place into both the strains of algae and the processes by which it is converted into fuel.¶ Mixing algal biomass with a solvent and catalyst produces a diesel-like substance called biodiesel, plus glycerol. Newer techniques are also emerging which mean products are not limited to biodiesel. Pyrolysis involves heating algae to very high temperatures (500-700°C) in the absence of oxygen to produce a bio-char (charcoal) and a wider range of fuel products. Hydrothermal liquefaction puts whole unprocessed algal material under pressure and temperatures of 250-350°C with water to produce ‘biocrude’ and hydrogen gas.¶ These processes essentially mimic the natural production of oil. Crude oil itself is formed from ancient algae, as well as other marine plankton. Algaenan, a tough hydrocarbon polymer found in algal cell walls, is turned to oil when layers of plankton are buried under the seabed and subjected to extreme heat and pressure.¶ Producing oil this way takes about 30 million years. Replicating the process in real time, at a scale vast enough to contribute to global demand, is the challenge.¶ Processes like pyrolysis can produce an oil equivalent from algae in about a day. But it’s important to consider quite how much oil we use before getting excited about algal fuels. Scott said: “At the moment we use 90 million barrels of oil, over 14 billion litres, every single day. You can fiddle around with a flask of new fuel and think we’re doing quite a good job, but we use a staggering amount of oil.”¶ There are great costs involved in growing and processing algae compared to just piping oil out of the ground. Algal cells produce more hydrocarbons when they are starved of nitrogen, so it is a two-step process, where the cells that are to be starved must be separated from the ones still growing. Also, the more microalgae you try to grow in one space, the less light gets through to each cell, meaning growth rate falls.¶ Andrew Spicer is scientific director of Algenuity, a company that provides support services to the emerging algal fuel industry. He says microalgal biofuel production will need to be stepped up from current levels of 100,000 tonnes a year to millions of tonnes per year if it is to replace petrol. Influential reports on biofuels say it is biology not industry that will help drive this, through strain selection and genetic engineering. Yet Spicer says it won’t be easy to translate bioengineering to industrial agriculture: genetically modified organisms are often hard to grow, but also many governments restrict the growth of them outdoors.¶ “To assume you can genetically modify an algal cell to produce more biofuel, and then expect it to grow it en masse, is perhaps naïve,” admitted Spicer.¶ Microalgae are starting to enter the genome editing realm. Metabolic engineering of biochemical pathways could achieve improved productivities, lower costs and improved energy balance. If we are accurately altering individual nucleotide bases, will this still be classed as genetic modification? It is under current legislation. Will it be acceptable to grow these algal in large scale, outdoor facilities?¶ The technology may not be here yet, but part of paving the way is to open the ethical debate.¶ Creative thinking about the uses of algae is also opening doors to new possibilities. One approach to the problems of scale and cost is to combine production of algal biofuels with another process. Many algal biofuel companies are changing direction to produce more expensive algal products rather than fuels. When algae are used to produce higher value products, such as pharmaceuticals, bioenergy could be produce as a ‘by-product’.¶ Macroalgae such as seaweed grows in vast quantities and can be farmed from the sea, or recovered from the beach. It also can provide valuable environmental services. Fish farms, for example, are serious polluters, with waste nitrogen damaging ecosystems. Some species of algae can contribute to waste water treatment and be converted into biofuel.¶ Yet before anything can be called a biofuel it must show its green credentials, said Dr Michelle Stanley, director of the NERC Algal Bioenergy Special Interest Group. “Seaweed beds on the ocean floor have an important role in preventing coastal erosion and removing beached kelp interferes with coastal ecosystems,” she said, “so you can’t just come along and take it all away.”¶ Stanley shared a prediction that 447 TJ of energy can be produced by macroalgae by 2020. That’s about 0.2% of current road fuel demands. China is well ahead when it comes to growing seaweed in shallow waters, producing an estimated 10 million tonnes a year. Elsewhere, production is still low.¶ Stanley said: “It all falls to pieces when it comes to economics. Costs can vary from €50 per tonne for nearshore, floating kelp, to €400 for offshore kelp, to €2500-plus for experimental systems.”

## Corn Ethanol Scenario

### AT Replaces Corn Ethanol

#### Corn ethanol is more lucrative than other biofuels – can’t displace it

Brad Plumer, 12/30/2011, The Washington Post, “can ethanol survive a hostile political climate?” <http://www.washingtonpost.com/blogs/wonkblog/post/can-ethanol-survive-a-hostile-political-climate/2011/12/30/gIQA1dJrQP_blog.html>

Ethanol used to be sacrosanct. Corn-based fuels have been subsidized by Congress for more than three decades, ever since the Energy Tax Act of 1978. And, given that corn-lovin’ Iowa always gets to go first in picking presidential nominees, ambitious politicians have long learned to gush over the virtues of the stuff.¶ ¶ But now that’s all changing. As Politico’s Alex Guillen reports, Republicans campaigning in Iowa are no longer averse to criticizing corn ethanol. Meanwhile, the ethanol tax credit, worth $6 billion per year, is set to expire this Sunday with nary a whimper from Congress. Ethanol’s defenders couldn’t surmount the combination of recent bad press for corn- and soy-based fuels — as it turns out, they can wreak havoc on the environment and cause food prices to spike — or the anti-subsidy mood in Washington. So what happens to ethanol now? First off, the ethanol industry as a whole will likely survive just fine. Just ask the ethanol producers themselves. There’s a reason why they quietly relented on trying to extend the 45-cent-per-gallon volumetric excise credit this year. After 30 years of subsidies, the industry is thriving. Oil prices remain high, making ethanol more competitive. The EPA’s Renewable Fuel Standard is still in place, which mandates that transportation fuel blend in a certain amount of ethanol, a form of government that’s arguably even more valuable than the tax credit. And U.S. exports of ethanol hit a record high in 2011, with some one billion gallons shipped abroad.¶ Instead, the key question is whether better ethanol will come along. After all, various peer-reviewed studies have found that ethanol made from corn and soybeans, far from being “clean” fuels, can often be worse for the environment than regular gasoline by driving up food prices and creating incentives for deforestation. So the hope has always been that some new, cleaner ethanol could come along — made from cellulosic crop waste, say, or from algae. Something that could displace gasoline without so many nasty side effects.¶ So far, though, that hasn’t happened. The EPA has already had to lower its targets for cellulosic ethanol in 2012, because companies aren’t making enough. As Nathan Greene of the Natural Resources Defense Council points out, corn ethanol was supposed to be a stepping stone to better fuels, but producers haven’t yet taken that step, in part because corn ethanol was too lucrative to give up.

#### Can’t replace corn ethanol – a federal mandate requires that 1/3 of our corn crop gets turned into ethanol

Joshua Kagan, 10/28/2009, Good Magazine, “why I love biofuels and hate ethanol,” <http://magazine.good.is/articles/why-i-love-biofuels-and-hate-ethanol>

According to Greentech Media, 76 percent of all federal renewable energy subsidies went to corn ethanol in 2007. Under mandates directed under the Energy Independence and Security Act, 15 billion gallons of corn ethanol is required to be blended into the U.S. gasoline supply by 2015. Assuming similar corn yield levels, we will soon be dedicating almost 50 percent of our corn crop to produce a fuel with debatable energy and carbon savings.

### AT Corn Ethanol Bad (Warming)

#### Corn ethanol carbon cuts are becoming more efficient

RFA 14 (Renewable Fuel Association, New Study: Corn Ethanol Reduces GHG Emissions by 37-40% Compared to Fracking and Tar Sands,¶ January 15, 2014, <http://www.ethanolrfa.org/news/entry/new-study-corn-ethanol-reduces-ghg-emissions-by-37-40-compared-to-fracking-/>) PS

WASHINGTON — A comprehensive new study (with appendix) conducted by Life Cycle Associates found that the carbon footprint of corn ethanol continues to shrink, while the carbon impacts associated with crude oil production continue to worsen as more marginal sources are introduced to the fuel supply. According to the report, “As the average carbon intensity of petroleum is gradually increasing, the carbon intensity of corn ethanol is declining. Corn ethanol producers are motivated by economics to reduce the energy inputs and improve product yields.”¶ The study, commissioned by the Renewable Fuels Association (RFA), found that average corn ethanol reduced greenhouse gas (GHG) emissions by 32% compared to average petroleum in 2012. Importantly, this estimate includes prospective emissions from indirect land use change (ILUC) for corn ethanol. When compared to marginal petroleum sources like tight oil from fracking and oil sands, average corn ethanol reduces GHG emissions by 37-40%. As more unconventional crude oil sources enter the U.S. oil supply, and as corn ethanol production processes become even more efficient, the carbon impacts of ethanol and crude oil will continue to diverge. By 2022, average corn ethanol reduces GHG emissions by 43-60% compared to petroleum, the study found.¶

#### Corn ethanol is net beneficial for GHGs – study accounts for negative production factors

Hernandez and Kasper 13 (Mari and Matt, An Overview of the Renewable Fuel Standard and Why It Is Good for the Climate, 2013, <http://americanprogress.org/issues/green/report/2013/12/11/80873/an-overview-of-the-renewable-fuel-standard-and-why-it-is-good-for-the-climate/>) PS

According to a peer-reviewed study by Argonne National Laboratory, corn ethanol, on average, lowers greenhouse gas emissions by 34 percent compared to conventional gasoline. The study took into account corn ethanol’s full production lifecycle, including fertilizer production, diesel used for farming, the transport of corn to the ethanol plant, the energy used to produce ethanol at the plant, the transport of ethanol to the market, and land-use changes.

### AT Corn Ethanol Bad (Food Prices)

#### Corn ethanol doesn’t trade off with food production

Graham-Rowe 11 (DUNCAN, Beyond food versus fuel, Nature, 23JUNE2011, <http://www.indiaenvironmentportal.org.in/files/food%20versus%20fuel.pdf>) PS

On the other side of the equation from improved farming practices, advanced bio- fuels could overcome many of the issues that have brought bioethanol and biodiesel into¶ ￼￼￼￼￼￼￼￼￼￼￼￼contention with food production. By using the entire plant and not just the edible parts, vastly different types of biomass become avail- able as starting materials, or feedstock. There is a lot more energy stored in the rest of the plant than the grain, but it’s harder to get at, says geneticist Chris Somerville, who directs the Energy Biosciences Institute at the Univer- sity of California, Berkeley. Consequently, this process is currently much more expensive than the production of corn ethanol (see ‘A chewy problem’, page S12).¶ To create Ferrari’s straw-based fuel, Iogen uses an enzyme from the ‘jungle rot’ fungus Trichoderma reesei. The fungus deploys this enzyme to extract nutrients from trees, by digesting lignin, one of the main components of lignocellulose, the woody part of plants. But the search is on to find more efficient enzymes. Enzymes for corn-ethanol processing are highly efficient and cost only about 2 US cents per US gallon, says Somerville. Enzymes that break down lignocellulose cost about 13–25 US cents per litre and that’s where the challenge lies. At the Energy Biosciences Institute, “we would like to reduce that cost by about half,” he says.¶ It might be possible to genetically engineer plants with lignin that is easier to break down, but this is a long way off, says Somerville. A more promising idea is to use selective breed- ing or genetic analysis to identify plants that are high in energy. Charles Wyman, a chemical and environmental engineer at the University¶ of California, Riverside, studied 47 variants of the poplar tree to determine which were most willing to give up sugar from their lignin — and what made that possible. In March 2011, his team reported that the sugar yield could range from as low as 28% up to 92% of the the- oretical maximum, depending not only on the lignin content but also on its structure.¶ So, if these technologies can be perfected and the costs of processing the waste parts of plants (or residues) can be reduced, this should sidestep the food versus fuel issue. For example, grain from corn could be harvested for food, while the rest of the plant could be rendered into fuel.

#### Corn ethanol is efficient – it avoids the “food versus fuel” debate

Goldman and Kole 14 (Stephen L., Chittaranjan, Compendium of Bioenergy Plants: Corn, p336, 2014¶ ) PS

There are obvious advantages for using corn residue as a biofuel feedstock. The practice will allow coproduction of food and fuel on the same land and therefore will not necessarily result in significant land use change. Corn residues currently represent the largest readily available supply of feedstock (DOE 2011). US production of corn grain exceeded 12.5 billion bushels in 2011 (NASS 2012), which means that by assuming a harvest index of 0.5, more than 290 million tons of residue will be produced. For several reasons, a substantial amount of this material will not be available to produce biofuels, but its sheer abundance underscores the potential. After evaluating ethanol production from corn grain and stover with respect to energy use, energy security, and resource conservation metrics, Lavigne and Powers (2007) concluded that using corn stover as a feedstock was more consistent with US national energy policy priorities than producing ethanol from grain.

#### Corn ethanol has a small impact on corn prices – mathematic studies over the past decade prove

Hornblower and Kelly 13 (Scott Hornblower is an associate analyst with GROWMARK, Kel Kelly is in charge of GROWMARK’s Economic and Market Research, Growmark is a national agricultural financing research and business association, “4 Reasons Why Ethanol Doesn’t Drive Corn Prices: A Tale of Two Forces” January 4, 2013, http://www.growmark.com/sites/Files/Documents/4ReasonsWhyEthanolDoesntDriveCornPrices.pdf)

According to our calculations, as of 2012, the increase in ethanol demand over the last twelve years could have¶ driven corn price up by a maximum of only $1.68 per bushel from the price of $1.85 in 2000 (the effect was 87¶ cents as of 2008). Buyers of corn for ethanol (“ethanol buyers”) have to spend money in order to acquire the corn. New and¶ additional spending in the corn market by ethanol buyers (increased demand) drives corn prices higher.¶ Therefore, the objective is to understand exactly how much new and additional spending the ethanol industry¶ brings to the corn market. Our analysis involves holding all other spending (i.e., spending from the Feed and¶ Residual Use, Exports, and Other FSI categories of corn use) constant at 2000 levels in order to isolate the effect on¶ price—given annual supply changes—that has been transmitted by ethanol buyers alone.¶ Mathematically speaking—given the (usually increasing) annual supply changes—for corn prices to rise from the¶ 2000 average price of $1.85 to the 2011 average price of $6.20, there must necessarily have been an annual¶ volume of $66.9 billion of additional spending over and above the $18.5 billion spent in 2000 to buy corn (Figure¶ 1). While that 345% increase in spending was what necessarily drove the corn price higher, the ethanol buyers¶ were responsible for only $29.8 billion or 44.5% of the increased spending. Their share of increased spending, by¶ itself, could have driven the price to only $3.53, or 39% of the $4.35 price increase that caused corn prices to¶ reach $6.20. Note that in Figure 1, spending by other market participants fell strongly in 2008 while spending by ethanol¶ producers continued to increase. The fact that corn prices fell substantially while ethanol demand remained¶ strong proves that it was the larger spending by other market participants, not the smaller spending by ethanol¶ buyers, which had the dominant effect on corn prices. This leads us to reason number two.

#### Corn prices and ethanol demand are completely unrelated – empirics prove

Hornblower and Kelly 13 (Scott Hornblower is an associate analyst with GROWMARK, Kel Kelly is in charge of GROWMARK’s Economic and Market Research, Growmark is a national agricultural financing research and business association, “4 Reasons Why Ethanol Doesn’t Drive Corn Prices: A Tale of Two Forces” January 4, 2013, http://www.growmark.com/sites/Files/Documents/4ReasonsWhyEthanolDoesntDriveCornPrices.pdf)

The ethanol industry has actually been buying corn since the early 1980s. But as Figure 2 shows, movements in¶ ethanol use are not correlated with movements in the price of corn—sometimes prices move in the same¶ direction as physical ethanol demand, sometimes they do not. For example, ethanol demand increased 303%¶ between 1995 and 2005, while prices fell by 38%. By 2006, ethanol demand represented over 19% of all corn use¶ (compared to 36% in 2012), but prices were no higher than 10 years prior. Similarly, ethanol demand for corn increased 24% between 2008 and 2009, while corn prices fell 20% (from the¶ intra-year high to intra-year low, corn prices plummeted by a whopping 60%!). Had ethanol been a dominant¶ corn price driver, the continued strong ethanol demand would have prevented a sell-off in the corn markets, and¶ would have instead driven corn prices higher due to the increased corn demand. Again, the relationship between corn price and ethanol demand appears to suggest that there are other influences¶ on corn prices that are stronger than ethanol demand alone.

#### Ethanol producers return large amounts of corn, making their impact smaller than predicted and could decrease prices

Hornblower and Kelly 13 (Scott Hornblower is an associate analyst with GROWMARK, Kel Kelly is in charge of GROWMARK’s Economic and Market Research, Growmark is a national agricultural financing research and business association, “4 Reasons Why Ethanol Doesn’t Drive Corn Prices: A Tale of Two Forces” January 4, 2013, http://www.growmark.com/sites/Files/Documents/4ReasonsWhyEthanolDoesntDriveCornPrices.pdf)

Ethanol producers use part of the corn kernel and return the rest of it to the market, where it is consumed by¶ others. This means that many traditional buyers of corn are no longer competing with ethanol buyers in the¶ primary market (i.e., buying corn first-hand from elevators). Instead, they can wait and obtain the corn¶ fermentation residual from ethanol producers at lower prices in the secondary market. As a result, non-ethanol¶ corn demand is reduced, causing less competition in the corn market. Ethanol Producer Magazine contributor¶ Mike Bryan states:¶ More than one-third of the corn used in the production of biofuels is put back into the market as the¶ high protein feed supplement distillers grains…so the 40 percent figure that is bandied about [that¶ ethanol producers use 40% of the corn crop] is, in reality, significantly lower, with some projections¶ showing the actual amount of corn value removed from the market is less than 20 percent.1¶ As the quote explains, ethanol producers’ purchases obviate the need for traditional buyers to compete in the¶ primary market, since the ethanol industry returns a significant portion of the corn it consumes back into the¶ secondary market. Granted, this quote could be seen as somewhat biased, given its publisher, but the essence of¶ the statement is factual. Ethanol producers are only extracting the sugars from the corn, leaving the leftovers,¶ about 33% of the processed corn, to re-enter the market for food processing and feed use.¶ In this way, additional value can be extracted from each of the 5 billion bushels of corn processed by the ethanol¶ industry. Feed and food consumers can obtain their corn input needs from distillers dried grains (DDGs), which¶ are considered a byproduct of fermentation. DDGs can be fed to livestock or chemically processed to extract food¶ grade oil and protein.¶ This should lead to less competition in the corn market, thus reducing ethanol producers’ need to out-compete¶ other buyers in the primary market by bidding up corn prices. With ethanol producers giving back a third of their¶ corn purchases, their impact on the market—whatever it is—is weaker than is apparent on the surface.

#### Corn prices rose because ALL prices rose, not because of ethanol

Hornblower and Kelly 13 (Scott Hornblower is an associate analyst with GROWMARK, Kel Kelly is in charge of GROWMARK’s Economic and Market Research, Growmark is a national agricultural financing research and business association, “4 Reasons Why Ethanol Doesn’t Drive Corn Prices: A Tale of Two Forces” January 4, 2013, http://www.growmark.com/sites/Files/Documents/4ReasonsWhyEthanolDoesntDriveCornPrices.pdf)

Perhaps the most obvious evidence that ethanol demand is not the primary driver of corn prices is the fact that it¶ is not just corn and other biofuel-oriented commodities that have experienced increased spending since 2006:¶ monetary demand and prices for almost all commodities have risen—and fallen—together (Figure 3).¶ Everything from sugar, orange juice, pork bellies, milk, and grains to silver, platinum, zinc, steel, coal, propane, and crude oil, have experienced both large price rises and price collapses, nearly simultaneously. This is not to¶ say that there have been one-for-one moves in prices by the month between these commodities; it is to say that,¶ while most commodities were largely flat during the 1980s and 1990s, almost all have seen substantial price¶ increases of 100-800% starting between 2002 and 2006, and most saw dramatic price collapses of 20-60%¶ during late 2008. While the demand for ethanol could affect the prices of corn and some other commodities, it cannot affect all¶ commodities. As the USDA stated:¶ The increase in biofuel production -- ethanol in the United States and Brazil and biodiesel¶ production in the EU, Argentina, and Brazil -- has played a role in raising prices for corn, sugar,¶ rapeseeds, and soybeans, as well as for other crops. Attributing most of the 2002-08 rise in food¶ commodity prices to biofuel production, however, seems unrealistic. Crop prices dropped more than¶ 20 percent during the last half of 2008, even though biofuel production continued to increase.¶ Further, nonagricultural prices rose more than agricultural prices, and the price of corn (an ethanol¶ feedstock) rose less than the price of rice and wheat (not biofuel feedstocks).2¶ While the first half of this USDA quote supports Reason #3 above, the second half brings home the point that if¶ ethanol demand were a primary driver in the corn market, commodities unrelated to biofuel production should not have increased and decreased in step with corn prices over the past five years. All the other commodities that¶ moved in a similar fashion to corn were not driven by biofuel demand. This co-movement between corn prices¶ and all other commodity prices once again suggests that a common factor, unrelated to ethanol, is shared among¶ these disparate commodities, and, is likely the significant driver of their price movements.

### AT Food Prices – Spikes Inevitable

#### Food price spikes inevitable – policy biases, protective trade barriers and lack of multilateral coop

Anderson 12 (Kym, Professor of Economics at University of Adelaide, Food price and trade policy biases: inefficient, inequitable, yet not inevitable, April 2012, <http://siteresources.worldbank.org/INTTRADERESEARCH/Resources/544824-1163022714097/3139581-1255722069727/6480306-1334003922558/OUP_Herring_handbook_0412.pdf>) PS

In short, the world’s food price and trade policy biases are still very wasteful of resources, they lead to food production occurring in higher-cost settings than is necessary, and they contribute to global poverty, to income inequality between countries, and to income and wealth inequality within rural areas of protective countries. Yet the historical data summarized above indicates that those policy biases have declined somewhat over the past quarter century. Thus even though it may seem like farm subsidies and import protection are fixtures too politically difficult to move, this evidence suggests those measures – like export taxes on farm products in developing countries – are not inevitable.¶ Unfortunately the same cannot yet be said for policies that insulate domestic food markets from international price fluctuations. While not discussed above (but see Anderson and Nelgen 2012), both high-income and developing countries alter their trade barriers in an attempt to protect consumers from food price spikes. It turns out, though, that both food- surplus and food-deficit countries tend to so respond, and to a similar extent. Hence they tend to cancel out each other’s ability to stabilize their home market – but at the same time they exacerbate the instability in international food prices (Martin and Anderson 2012). Beggar- thy-neighbor food policy actions are thus a long way from being a thing of the past, and are likely to continue until enough countries get together and agree multilaterally to desist from protecting and insulating their domestic food markets.\

#### Food price spikes inevitable – lack of policy and underinvestment

Jayasuriya et. al 12 (Sisira, Purushottam Mudbhary, Sumiter Singh Broca, Food price spikes, increasing volatility and global ¶ economic shocks: coping with challenges to food security ¶ in Asia, 2012, <http://www.fao.org/3/a-i3031e.pdf>) PS

It is clear that each country should review the set of policy instruments available to cope ¶ with food security in a context of high and volatile international price setting to develop ¶ strategies to cope with unanticipated shocks, whether of internal or external origin. ¶ A key policy message from our study is the imperative and urgent need to reverse the ¶ underinvestment in food and agriculture. ¶ ¶ The continuing food price pressures are a signal of tight supply/demand conditions in ¶ global food markets; in tight markets, where demand is very inelastic, relatively minor ¶ shocks can produce sharp spikes and high volatility. ¶ Long-term imbalances and periodic ¶ sharp price spikes are inevitable unless production increases can keep pace with projected ¶ demand increases from both higher global population and higher incomes. The world ¶ cannot afford to be complacent about food production. ¶ ¶ Another policy message is the need to have a set of policies in place that can reduce the ¶ volatility in food prices, while coping with shocks that will occur from time to time. The ¶ realistic challenge is to design policies and measures to reduce and manage volatility, ¶ rather than seek to eliminate it because volatility in food markets is nothing new and will ¶ never disappear.

#### Alt cause: over speculation is the biggest cause of corn price spikes

Hornblower and Kelly 13 (Scott Hornblower is an associate analyst with GROWMARK, Kel Kelly is in charge of GROWMARK’s Economic and Market Research, Growmark is a national agricultural financing research and business association, “4 Reasons Why Ethanol Doesn’t Drive Corn Prices: A Tale of Two Forces” January 4, 2013, http://www.growmark.com/sites/Files/Documents/4ReasonsWhyEthanolDoesntDriveCornPrices.pdf)

This other strong force that has been alluded to, that is present in both the corn and other commodity markets, is¶ the actions of Wall Street investors, or so-called “speculators.” It is these financial markets investors looking to¶ profit in the corn futures market, not commercial consumers like ethanol plants, hog and cattle farmers, and food¶ processors, who are responsible for recent price volatility.¶ While a small portion of Wall Street investors has always been involved in the commodity markets, most current¶ investors came to the commodity markets between 2002 and 2006 (1998 for the energy markets). Those¶ investors were: 1) fleeing the collapsing stock markets in the early 2000s and 2) looking for diversification, since¶ most asset classes had become increasingly correlated with each other, but commodities were still uncorrelated¶ with other asset classes. The investors that came to the commodity markets brought with them new, highly¶ leveraged funds for investing that had not previously been in the commodity markets. These funds represented¶ new money flows and purchasing power that competed with existing purchasing power (Figure 4). Since 2006,¶ over 70% of transactions in the corn futures market have consisted of speculator funds, and 40% of those¶ transactions come from index investors specifically.¶ Index investors are pension fund, hedge fund, and mutual fund managers looking to profit from the volatility in¶ the corn market by buying corn futures and “rolling” them from month to month like traditional investments.¶ While these investors tend to buy corn futures as longer term investments (pushing prices higher), they quickly¶ sell out of their positions when the market turns for the worse (causing prices to fall precipitously).

#### Food spikes inevitable – dwindling reserves, population

Schuman 11 (Michael, A Future of Price Spikes, 2011, <http://content.time.com/time/business/article/0,8599,2083276-2,00.html>) PS

With demand steadily rising, the world is closer to disaster because the food safety net has shrunk. In the late 1990s, we had enough corn stashed in reserve to meet world demand for about four months; now we have enough for only about 2/3. From more than four months' supply of wheat in storage, we have gone down to just over three (and in recent years, reserves have fallen even further).¶ That's made global food markets susceptible to ever more extreme price spikes caused by floods, droughts and other unpredictable acts of Mother Nature. Wheat prices soared last summer when wildfires and drought destroyed a third of Russia's grain crop, while corn prices reached dizzying heights in part because of a weak harvest in the U.S. "There's not much of a cushion to deal with any kind of shocks, and shocks are what we're getting," says Soozhana Choi, head of commodities research for Asia at Deutsche Bank in Singapore.¶ (See pictures of what the world eats.)¶ High food prices are bad news for everyone. Rising prices have stoked inflation in China and India, forcing their central banks to hike interest rates to dampen growth. Because emerging markets have been driving the global recovery, slower growth in China and India is a drag on the world economy. Bigger grocery bills also hurt growth by eating into consumer spending. As a larger portion of people's paychecks is spent on bread and beef, less is left to buy LCD TVs, cars and plane tickets.¶ The pain caused by expensive food is especially severe for the poor. Low-income families in Africa and elsewhere tend to spend a majority of what they earn on food, so high prices make them poorer, hungrier or both. The World Bank estimates that 44 million people in the developing world have been thrown back into poverty by recent price increases. In the village of Saddarpur, not far from New Delhi, food has become so pricey that Nimmi Singh, a domestic helper, had to triple the number of houses she cleans to bring in extra rupees. "We have a hand-to-mouth existence anyway," Singh complains. Now "the markets are totally untouchable."¶ Although commodity prices have retreated from their highs, prices overall are expected to remain much higher than they were in the past. "All the factors that cause food-price spikes are going to continue into the future," says Jay Naidoo, chair of the Global Alliance for Improved Nutrition, "and it's going to get worse." In a June report, the FAO and the Organisation for Economic Co-operation and Development (OECD) estimated that cereal prices will rise as much as 20% and meat prices up to 30% over the course of this decade compared with the previous one. "We talk scarcenomics," says Craig Cogut, founder of Pegasus Capital Advisors, a New York City — based private-equity firm. "When you look at food and water and energy, you see rising populations and resources becoming scarcer. Rising food prices are a fact of life." Pegasus has invested in a joint venture that sells organic and antibiotic-free chicken and turkey.

### AT Food Prices – AT Famine

#### High food will not cause any famine – it will help prevent famine

MacMillan, 6/25

(Andrew MacMillan, A journalist for the Inter Press Service, a news agency that focuses on the Earth’s environment.,S Inter Press Service, “Higher Food Prices Can Help to End Hunger, Malnutrition and Food Waste”, June 25, 2014, http://www.ipsnews.net/2014/06/higher-food-prices-can-help-to-end-hunger-malnutrition-and-food-waste/)

It seems dreadfully wrong that the very people who produce so much of our food should be those who suffer most from deep poverty and food shortages. One reason for this apparently unjust situation is what economists call asymmetrical relationships in the food chain. For instance, supermarkets engage in cut-throat competition for customers by lowering their prices, reducing what they pay to their suppliers who, in turn, cut back on their workers’ pay. Most governments like to keep food prices “affordable”, claiming that it makes food accessible to poor families, thereby preventing hunger and malnutrition. The main policy instruments used by rich and emerging nations include tax-funded subsidies that compensate their farmers for low-priced food sales. They also set low taxes on most foods. The idea that low food prices will reduce the scale of the hunger problem is flawed since the main reason for people being hungry is that they cannot afford the food they need, even when prices are low. Rather than, as now, shielding all consumers from paying a full and fair price for food, it seems to make more sense to let prices rise and increase the food buying power of the poor. As Fair Trade customers have discovered, higher retail prices can be passed back to all those involved in the food production chain, especially farm labourers. They probably offer the best market-driven option for cutting rural poverty and hunger.

### AT Honeybees – Alt Causes

#### Mites are an alt cause for bee decline worldwide

The Age, 6/26/12, "this mite be the bee's worst enemy," <http://www.theage.com.au/technology/sci-tech/this-mite-be-the-bees-worst-enemy-20120626-20z6u.html>

Although bees have not disappeared yet, the insects that collect nectar and pollen and make honey and wax are in precipitous decline: populations in the US and Britain, for example, have halved over the past 25 years. Reasons for the decline range from the prevalence of chemicals, particularly common crop pesticides, to the destruction of flower-rich habitats and the rise in electromagnetic radiation from mobile telephone towers and transmission lines. The biggest pest threat is from the evil-sounding Varroa destructor, an oval-shaped, reddish-brown mite that sucks the blood from bees and transmits virulent diseases, such as deformed-wing virus. The pinhead-sized bloodsuckers have decimated bee populations worldwide, including in neighbouring New Zealand and Papua New Guinea, but have not arrived yet in Australia.

### AT Honeybees - Replaceable

#### Honeybees are replaceable

Christopher Mims, 7/14/09, Scientific American, "replacing the honeybee," <http://www.scientificamerican.com/article.cfm?id=replacing-the-honeybee>

Honeybees have been dying in record numbers, yet many commercial crops depend on them for pollination. Entomologists who have been struggling to find an alternative now report that another bee might fill the void. The blue orchard bee, also known as the orchard mason bee, is undergoing intensive study by the U.S. Department of Agriculture pollinating insect research unit at Utah State University at Logan. James Cane, an entomologist there, says a million blue orchards are now pollinating crops in California. Like honeybees, the species can pollinate a variety of flora, including almond, peach, plum, cherry and apple trees. Unlike honeybees, however, they tend to live alone, typically in boreholes made by beetles in dead trees. In cultivation, the bees will happily occupy holes drilled into lumber or even Styrofoam blocks. The blue orchards rarely sting and, because of their solitary nature, do not swarm. They are incredibly efficient pollinators: for fruit trees, 2,000 blue orchards can do the work of 100,000 honeybees. Their biggest drawback is that beekeepers can increase their population only by a factor of three to eight a year; a honeybee colony can expand from several dozen individuals to 20,000 in a few months. “We’re still in the development stage” of applying the USDA’s research, says David Moreland, CEO of AgPollen, which is supplying blue orchard bees to the California almond industry. Last season local almond growers were paying up to $300 for enough honeybees to work an acre, 10 times what they paid a decade ago, making the blue orchard bees cost-competitive, albeit only barely.

### AT Monocultures

#### Monocultures good – sustainable biodiversity, minimal pest damage, no direct environmental harm

Wood 2k (David, In defense of monocultures, ILEIA NEWSLETTER¶ 2000¶ <http://www.agriculturesnetwork.org/magazines/global/monocultures-towards-sustainability/in-defense-of-monocultures>) PS

Concern over the ability of crop monocultures to maintain associated biodiversity may be misplaced. There is now substantial evidence that single crops such as rice have self-regulation through great crop-associated biodiversity. At higher trophic levels, including parasites and predators on the herbivores, there is yet more diversity.¶ Management of the crop cycle to increase detritus from the rice crop could encourage detritus feeders and, in turn, natural enemies of rice pests, contributing to substantial biodiversity in a monoculture, and, under most circumstances, minimal pest damage. Indeed, the main problem with monocultures in Green Revolution agriculture could be the loss of associated biodiversity due to the use of agrochemicals, intensive tillage and the large-scale of production, rather than the monoculture itself. More information is needed from wild ecosystems to indicate how the biodiverse properties of natural monocultures can be maintained in agriculture.¶ Conclusions¶ Hither to agroecologists have claimed that sustainability results only from complex polycultures, which mimic complex - and therefore stable - natural ecosystems. While this may be true for more equable tropical regions, it may not always apply to seasonally disturbed or marginal environments. Indeed, cereal cropping – producing most of our food - may be a close mimic of structurally simple but seasonally stressed and disturbed natural grassland ecosystems.

## Warming

### Algae Biofuels Can’t Solve Warming

#### Algae biofuels can’t solve warming

CATF 13 Clean Air Task Force is a research paper citing studies and research on Algal Biofuel development. “The Status of Biofuel Development.” <http://www.catf.us/resources/whitepapers/files/201307-CATF%20Status%20of%20Algal%20Biofuels.pdf> July 2013.

If algal biofuels are to become part of the next generation of alternative transportation ｶ fuels, they will need to be less energy and carbon intensive than conventional ｶ transportation fuels are. That claim cannot be upheld today. With current technologies and ｶ methodologies in place, algal biofuel is not presently an improvement over conventional ｶ fossil-based transportation fuels economically or as a means to mitigate climate change ｶ (Georgianna & Mayfield, 2012). Without accounting for the environmental externalities ｶ through a quantity or price policy mechanism like a carbon tax, the price per gallon of an ｶ algal biofuel is still substantially more than that of conventional gasoline or diesel. Even ｶ more challenging, the energy return on investment of algal biofuel remains too low – a ｶ good 5 to 10 times less than that of gasoline at the pump (Beal et al., 2012, p. 693) – at the ｶ present time to make it sustainable (NRC, ｶ 2012). In other words, the energy input that a ｶ system requires to produce biofuel from algae ｶ is often more than the energy that it in return ｶ can generate.

#### Algae biofuels emit the net same amount of emissions as fossil fuels

Christi 13 “Constraints to commercialization of algal fuels,” Yusuf Chisti. 22 July 2013. (http://www.tamu.edu/faculty/tpd8/BICH407/Chisti%202013%20Journal%20of%20Biotechnology.pdf)

Production of algal biofuels requires input of energy derived¶ from fossil fuels. Fossil energy is used to mix and pump the culture¶ broth, recover the biomass from the water via filtration and other¶ processes, and extract the oil from the biomass. The algal crude oil¶ produced has a certain energy content. Energy ratio, the ratio of the¶ energy contained in the oil to the fossil energy required for making¶ it, is an important measure that determines whether production of¶ oil is worthwhile (Chisti, 2008b). An energy ratio of unity implies¶ a nil net recovery of energy in the oil. Ideally, an energy ratio of¶ well above unity is wanted, preferably a value of at least 7. Achieving¶ a high energy ratio requires the spent biomass to be used in¶ production of biogas for generating power to run the biomass production¶ processes. Recovery of N and P fertilizers in the effluent of¶ anaerobic digester can actually improve the energy ratio of algal¶ crude oil. In addition, the processes of biomass production, recovery¶ from water and oil extraction must be engineered to minimize¶ fossil energy input (Chisti, 2008b; Sompech et al., 2012; Wongluang¶ et al., 2013). Not much attention has been given to this issue so far.¶ An energy ratio of 1.4 has been estimated for algal diesel (Liu et al.,¶ 2012a), but this may be low and has the potential to be greatly¶ improved (Chisti, 2008b). Ideally, an energy ratio of at least 7 is¶ wanted (Chisti, 2008b).¶ Energy ratio estimates for algal biodiesel have generally been¶ less than unity (Khoo et al., 2011), but many such estimates are¶ based on unrealistic assumptions. For example, an energy ratio¶ of¶ ∼0.5 has been estimated for biodiesel production from algae¶ in a process involving drying of biomass prior to solvent extraction¶ and no recovery of energy from the spent biomass (Khoo¶ et al., 2011). Other similar theoretical assessments have produced¶ low estimates of energy returns (Cooney et al., 2011; Beal et al.,¶ 2012). Any oil production process involving high-g centrifugal recovery¶ of the biomass, energy-intensive physical breakage of the algal cells,¶ drying of the biomass prior to extraction, use of the supercritical¶ extraction methods, and membrane-based oil recovery techniques,¶ is unlikely to be energy efficient. As discussed elsewhere in this¶ review, production methods involving flocculation–sedimentation¶ in combination with low-g centrifugation or continuous belt filtration¶ should be considered for biomass recovery. The oil must be¶ extracted from a moist biomass paste, unless the cells have been¶ engineered for autolysis or secretion of the oils. The energy efficiency¶ as well as biomass productivity of raceway ponds can be¶ improved to some extent by changes to design (Sompech et al.,¶ 2012). Similar improvements in energy efficiency have been envisaged¶ for photobioreactors (Wongluang et al., 2013). Hydrothermal¶ liquefaction (Barreiro et al., 2013) of whole biomass, or spent¶ biomass, may offer other opportunities for enhancing the energy¶ ratio of algal fuels.

#### Studies concerning carbon footprint of algae biofuels are inconsistent

Christi 13 “Constraints to commercialization of algal fuels,” Yusuf Chisti. 22 July 2013. (http://www.tamu.edu/faculty/tpd8/BICH407/Chisti%202013%20Journal%20of%20Biotechnology.pdf)

Carbon footprint (Zamboni et al., 2011) is a measure of the¶ amount of carbon released in production and use of a given quantity¶ of a material. The carbon footprint of an algal fuel relative to the¶ carbon footprint of the petroleum fuel it displaces, is a key factor¶ in determining whether its production is worthwhile. The carbon¶ footprint of an acceptable biofuel must be smaller than the footprint¶ of petroleum on an equal energy basis. This aspect has been¶ so far largely ignored for algal fuels. Algal oil production technologies¶ need to be designed to minimize the carbon footprint of the¶ oil.¶ The published life-cycle analyses of algal fuels (Lardon et al.,¶ 2009; Batan et al., 2010; Clarens et al., 2010; Jorquera et al., 2010;¶ Sander and Murthy, 2010; Stephenson et al., 2010; Brentner et al.,¶ 2011; Campbell et al., 2011; Clarens et al., 2011; Khoo et al., 2011;¶ Kucukvar and Tatari, 2011; Pfromm et al., 2011; Shirvani et al.,¶ 2011; Singh and Olsen, 2011; Yang et al., 2011a,b; Frank et al.,¶ 2012) have been generally inconclusive with respect to their sustainability.

#### Turn: necessary fertilizers mean algae increases emissions

Bhanoo 10 (Sindya N. Bhanoo, observatory columnist for the New York Times, “Study Examines Costs and Benefits of Algae” January 25, 2010 http://green.blogs.nytimes.com/2010/01/25/study-examines-costs-and-benefits-of-algae/)

Last week, the government doled out more than $80 million in stimulus money for biofuels research, much of which will be focused on algae research.¶ But a recent study, published in the journal Environmental Science and Technology, suggests that algae production is energy intensive and can end up emitting more greenhouse gases than it sequesters. Other biofuel crops like corn, canola and switchgress result in a net carbon dioxide uptake, the study found.¶ The main reason for this is that fertilizers have to be directly delivered to the pool of water that algae is growing in, said Andres Clarens, an assistant professor of civil engineering at the University of Virginia Civil and a lead author on the paper. And fertilizers are very energy intensive to produce.¶ Corn and switchgrass can draw nitrogen from soil, which reduces the overall amount of fertilizer required, he said. In addition, crop rotation can help replenish soil nutrients.¶ “Nutrients are going to be the limiting factor,” Dr. Clarens said. “We’re humans. We need to eat dinner, and you can’t expect to have algae that provides a bunch of energy without feeding it nutrients.” Cuello says if current methods were to be scaled up to meet the 5-percent goal, algal biofuel production would consume too much water, energy, and nutrients to be environmentally sustainable at this point. Additional concerns voiced in the report are the amount of land area needed for algae ponds and uncertainties in greenhouse gas emissions over the production life cycle.¶ “For example, to produce those 10 billion gallons of biofuel, you’d need about 33 billion gallons of water,” Cuello says. “That is a huge concern.”¶ “Resource consumption is very dependent on which technology components you combine and how you combine them to constitute a biofuel production pathway that is both environmentally sustainable and economically viable,” he explains.¶ Most of the current development involves growing selected strains of algae in open ponds or closed photobioreactors using various water sources, collecting and extracting the oil from algae, or collecting fuel precursors secreted by algae, and then processing the oil into fuel.¶ All the factors¶ “Our report brings awareness to address the concerns of making production not only commercially viable but environmentally sustainable,” he says. “In my opinion, you can’t divorce the two. As a matter of fact, most efforts aiming at lowering the production costs is to make the process more sustainable in terms of energy, water, and nutrient use.”¶ To produce 10 billion gallons of algal biofuels, 6 million to 15 million metric tons of nitrogen and 1 million to 2 million metric tons of phosphorus would be needed each year if the nutrients are not recycled, the report says. These requirements represent 44 percent to 107 percent of the total nitrogen use and 20 percent to 51 percent of the total phosphorus use in the US.

#### Studies prove algae fuel don’t lower emissions

Christiansen 11 (Katrina Lea Christiansen, professor of agriculture engineering, Iowa State University “Cost structures and life cycle impacts of algal biomass and biofuel production” 2011)

First, two models developed by the RAND corporation were employed to assess Cost Growth defined as the ratio of actual costs to estimated costs, and Plant Performance defined as the ratio of actual production levels to design performance, of three algal biofuel production technologies. The three algal biofuel production technologies examined to open raceway ponds (ORPs), photobioreactors (PBRs), and a system that couples PBRs to ORPs (PBR-ORPs). Though these analyses lack precision due to uncertainty, the results highlight the risks associated with implementing algal biofuel systems, as all scenarios examined were predicted to have Cost Growth, ranging from 1.2 to 1.8, and Plant Performance was projected as less than 50% of design performance for all cases. Second, the Framework the Evaluation of Biomass Energy Feedstocks (FEBEF) was used to assess the cost and environmental impacts of biodiesel produced from three algal production technologies. When these results were compared with ethanol from corn and biodiesel from soybeans, biodiesel from algae produced from the different technologies were estimated to be more expensive, suffered from low energy gains, and did not result in lower greenhouse gas emissions. To identify likely routes to making algal biofuels more competitive, a third study was undertaken. In this case, FEBEF was employed to examine pinch-points (defined as the most costly, energy consuming, greenhouse gas producing processes), in three algal production and fuel conversion scenarios, and then to estimate the improvement to cost and environmental impacts of proposed solutions to the pinch-points. These results illuminated significant opportunities to improve the economics and environmental impacts from producing algal biofuels produced in ORP, PBR, and PBR-ORPs. No single solution examined appeared to be sufficient to reduce the cost of fuel energy from algae to a competitive level with current petroleum diesel prices (4.20 $/gal, ca. $28/GJ). However, if multiple pinch-points are overcome, e.g., simultaneous increases in (1) radiation use efficiency and (2) oil content or simultaneous decreases in (3) irrigation, (4) harvesting, (5) labor and (6)PBR costs are achieved then low Fuel Energy Costs (the ratio of total production and conversion costs to total energy available in the fuel) and low Total Energy Costs (the ratio of total production and conversion costs to total energy available in the fuel and co-products) are possible; with estimates ranging from 48 to 11 $/GJ.

### AT Warming - Not Human Caused

#### Global warming natural phenomenon, not anthropogenic

**Lupo 13**

(Anthony; assistant director of atmospheric science at the University of Missouri at Columbia; Global warming is Natural; Not man made; 2013; http://www.napsnet.com/pdf\_archive/34/50144.pdf)

(NAPSA)—One of the fundamental tenets of our justice system is one is innocent until¶ proven guilty. While that doesn’t¶ apply to scientific discovery, in the¶ global warming debate the prevailing attitude is that human¶ induced global warming is already¶ a fact of life and it is¶ up to doubter s to¶ prove otherwise.¶ To complete the¶ analogy, I’ll add that¶ to date, there is no¶ credible evidence to¶ demonstrate that the climatological changes we’ve seen since the¶ mid-1800’s are outside the bounds¶ of natural variability inherent in¶ the earth’s climate system.¶ Thus, any impartial jury¶ should not come back with a¶ “guilty” verdict convicting humanity of forcing recent climatological¶ changes.¶ Even the most ardent supporters of global warming will not¶ argue this point. Instead, they¶ argue that humans are only partially responsible for the observed¶ climate change. If one takes a¶ hard look at the science involved,¶ their assertions appear to be¶ groundless.¶ First, carbon dioxide is not a¶ pollutant as many claim. Carbon¶ dioxide is good for plant life and is¶ a natural constituent of the¶ atmosphere. During Earth’s long¶ history there has been more and¶ less carbon dioxide in the atmosphere than we see today.¶ Second, they claim that climate¶ is stable and slow to change, and¶ we are accelerating climate¶ change beyond natural variability.¶ That is also not true.¶ Climate change is generally a¶ regional phenomenon and not a¶ global one. Regionally, climate has¶ been shown to change rapidly in¶ the past and will continue to do so¶ in the future. Life on earth will¶ adapt as it has always done. Life¶ on earth has been shown to thrive¶ when planetary temperatures are¶ warmer as opposed to colder.¶ Third, they point to recent¶ model projections that have¶ shown that the earth will warm¶ as much as 11 degrees Fahrenheit¶ over the next century.¶ One should be careful when¶ looking at model projections. After¶ all, these models are crude representations of the real atmosphere¶ and are lacking many fundamental processes and interactions¶ that are inherent in the real¶ atmosphere. The 11 degrees scenario that is thrown around the¶ media as if it were the mainstream prediction is an extreme¶ scenario.¶ Most models predict anywhere¶ from a 2 to 6 degree increase over¶ the next century, but even these¶ are problematic given the myriad¶ of problems associated with using¶ models and interpreting their¶ output.¶ No one advocates destruction¶ of the environment, and indeed¶ we have an obligation to take care¶ of our environment for future generations. At the same time, we¶ need to make sound decisions¶ based on scientific facts.¶ My research leads me to¶ believe that we will not be able to¶ state conclusively that global¶ warming is or is not occurring for¶ another 30 to 70 years. We simply¶ don’t understand the climate system well enough nor have the¶ data to demonstrate that humanity is having a substantial impact¶ on climate change.¶ Anthony R. Lupo is assistant¶ professor of atmospheric science at¶ the University of Missouri at¶ Columbia and served as an expert¶ reviewer for the UN’s Intergovernmental Panel on Climate Change.

#### Global warming is not supported by actual data

Newman, 13

(Maurice; former Chairperson of the Australian Secrurities Exchange and the ABC; “Climate change science has become an expensive smokescreen”; The Australian; 7/3/13) AKD

Vested interests are hidden but sooner or later the laws of economics will prevail SIGNING off as ``Mr FOIA'', the person who leaked the emails from East Anglia University that came to be known as ``Climategate'' and that drew a line in the snow at the Copenhagen Climate Summit recently released to a select few the password to the files containing 220,000 emails. He didn't expect the remaining emails to hold big surprises and observed, ``Even if I have it all wrong and these scientists had a good reason to mislead us (instead of making a strong case with real data) I think disseminating the truth is still the safest bet by far.'' Indeed it is. That so many scientists have found it necessary to mislead us on anthropogenic global warming is an admission of political intent and the absence of a strong scientific case. Since the release of the original Climategate emails, more revelations have come to light to support this contention. The Delinquent Teenager exposed how non-government organisations such as Greenpeace and WWF, captured the Intergovernmental Panel on Climate Change. The book provides irrefutable evidence that what had once been accepted as the ``gold standard'' of climate science was nothing of the sort. There was a second release of damaging Climategate emails and alarmist headlined research that had to be hastily withdrawn (without headlines) for want of rigour. There was another hockey stick that admitted groundless data and dire warnings of extreme weather events without evidence that a new normal had begun. Despite this, the voices of alarm and authority have been unable to hide the reality that, statistically, there has been no increase in global temperatures since 1997, despite an 8.3 percent rise in atmospheric CO2. For those who want to cite warming in some records, all datasets agree there has been none since 2000. In fact since 2002 a slight cooling has been observed. Who knew? Well, not the warmist scientists. Indeed, the ABC reported: ``A study forecasts that global warming will set in with a vengeance after 2009, with at least half of the following five years expected to be hotter than 1998, which was the warmest year on record.'' Wrong. Even recent claims of an ``angry'' Australian summer were not validated by satellite data. Roy Spencer, from the University of Alabama, compared 73 warming predictions to actual data across 34 years. Ending in 2012, he found an extraordinary discrepancy between what the models predicted and the actual observations of satellites and balloons. The predictions were all strongly biased to the upside. As he commented, ``I frankly don't see how the IPCC can keep claiming that the models `are not inconsistent with the observations'. Any sane person can see otherwise.'' Scientists have long searched for a ``hot spot'' in the atmosphere. When it could not be found, some said it must be in the oceans. Yet, since the deployment in 2003 of 3000 Argo floats (the acme of ocean temperature measurement), researchers still haven't found it. While CO2 may be a greenhouse gas, it seems that natural forces dominate climate change, not mankind's emissions. Henrik Svensmark's theory of cosmoclimatology (the role of cosmic rays) may be right. With such mounting evidence it is hard to remain agnostic. Yet, rather than undertake a thorough rethink of US climate change policy, President Barack Obama prefers to champion discredited research to justify more initiatives that will squander the US's newly found natural gas competitiveness. He ignores the experience of Germany, the world's emissions abatement champion. Germans discovered wind power generates only 17 per cent of plated capacity and juggling intermittent wind and solar power through the grid causes costly supply interruptions that offset CO2 savings. To ensure reliability and having shunned further nuclear investment, Germany is now building coal and gas-fired power stations. But even with the world's second highest household electricity prices, it will probably miss its 2020 EU targets. Worse, German business is becoming less competitive despite alleged inadmissible subsidies for energy intensive industries. German corporations pay 2.2 times more for electricity than their US counterparts. But it's not easy to stop a trillion-dollar juggernaut with facts. Any supranational emission reduction scheme that enforces conformity, provides generous subsidies, centralises authority, reduces competition, entrenches privilege for bureaucrats and the political class, and offers taxpayer-funded trips for the faithful to exotic locations will be strongly defended while the visible hardships these policies inflict are casually dismissed. This is the world of climate change. The science has become an expensive smokescreen behind which vested interests hide. Sooner or later, though, the laws of economics, which are more certain than the laws of anthropogenic global warming, will prevail and determine the sustainability of these gestures. Once upon a time legislators could justify the need to enforce reductions in CO2 emissions. Today we know these policies are based on back-to-the-drawing-board science and we have firsthand knowledge of their growth-slowing, economy-distorting, job-destroying impact. In the meantime, the UN is claiming damages for ``climate injustice with a human rights dimension'' inflicted by wicked Western ``polluters'' on poor developing countries. It wants huge financial compensation. Legitimate or not, any such claim of injustice pales in comparison to the ongoing harm and callous indifference shown by wealthy governments towards their own people. This, is the greatest moral challenge of our time.

#### Global warming isn’t happening

Watts 2013

(Anthony- Meteorologist; “Global Warming theory has failed all tests, so alarmists return to the ‘97% consensus’ hoax”

<http://wattsupwiththat.com/author/wattsupwiththat/>) ck

National Academies of Science defines a scientific theory as “a well-substantiated explanation of the natural world that can incorporate facts, laws, inferences, and tested hypotheses.” Dr Richard Feynman, Cornell Physicist in a lecture explained how theorys that failed the test of data or experiment are falsified (“wrong”) and must be discarded. Global Warming Theory Has Failed (1) Warming not ‘global’. It is shown in satellite data to be northern hemisphere only (2) It is now not warming. Warming (global mean and northern hemisphere) stopped in the 1990s (3) Models suggest atmosphere should warm 20% faster than surface but surface warming was 33% faster during the time satellites and surface observations used. This suggests GHG theory wrong, and surface temperature contaminated. (4) Temperatures longer term have been modified to enhance warming trend and minimize cyclical appearance. Station dropout, missing data, change of local siting, urbanization, instrumentation contaminate the record, producing exaggerating warming. The GAO scolded NOAA for poor compliance with siting standards. (5) Those who create the temperature records have been shown in analysis and emails to take steps to eliminate inconvenient temperature trends like the Medieval Warm Period, the 1940s warm blip and cooling since 1998. Steps have included removal of the urban heat island adjustment and as Wigley suggested in a climategate email, introduce 0.15C of artificial cooling of global ocean temperatures near 1940. (6) Forecast models have failed with temperature trends below even the assumed zero emission control scenarios (7) Climate models all have a strong hot spot in the mid to high troposphere in the tropical regions. Weather balloons and satellite show no warming in this region the last 30 years. (8) Ocean heat content was forecast to increase and was said to be the canary in the coal mine. It too has stalled according to NOAA PMEL. The warming was to be strongest in the tropics where the models were warming the atmosphere the most. No warming has been shown in the top 300 meters in the tropical Pacific back to the 1950s. (9) Alarmists had predicted permanent El Nino but the last decade has featured 7 La Nina and just 3 El Nino years. This is related to the PDO and was predicted by those who look at natural factors. (10) Alarmists had predicted much lower frequency of the negative modes of the AO and NAO due to warming. The trend has been the opposite with a record negative AO/NAO in 2009/10 (11) Alarmists predicted an increase in hurricane frequency and strength globally but the global activity had diminished after 2005 to a 30+ year low. The U.S. has gone seven consecutive years without a landfalling major hurricane, the longest stretch since the 1860s (12) Alarmists have predicted a significant increase in heat records but despite heat last two summers, the 1930s to 1950s still greatly dominated the heat records. Even in Texas at the center of the 2011 heat wave, the long term (since 1895) trends in both temperature and precipitation are flat. And when stations with over 80 years of temperature data were considered, the number of heat records last July were not extraordinary relative to past hot summers. (13) Extremes of rainfall and drought were predicted to increase but except during periods of strong El Nino and La Nina, no trends are seen (14) Alarmists indicated winter would become warmer and short. The last 15 years has seen a decline in winter temperatures in all regions. In places winter have been the coldest and longest in decades and even centuries. (15) Alarmists had indicated snow would become increasingly rare in middle latitudes especially in the big cities where warming would be greatest. All time snow records were set in virtually all the major cities and northern hemisphere snow coverage in winter has increased with 4 of the top 5 years since 2007/08. Also among the east coast

#### **There is no legitimate scientific consensus that global warming is real**

Scott 13

(John, “A Really Inconvenient Truth: Global Warming is Not Real,” Mentor Mob, Apr 25 2013, http://www.mentormob.com/learn/i/climate-change-2/a-really-inconvenient-truth-global-warming-is-not-real

Sixteen prominent scientists recently signed an[op-ed in the Wall Street Journal](http://online.wsj.com/article/SB10001424052970204301404577171531838421366.html) expressing their belief that the theory of global warming is not supported by science. This has not been getting the attention it deserves because politicians (looking at you Al Gore) are frankly embarrassed to admit that they are wrong about the phenomenon known as global warming. Not only has our planet stopped warming, but we may be headed toward a vast cooling period.¶ New data shows that in fact the Earth has not warmed at all over the last 15 years. In fact, theDaily Mail [reports](http://www.dailymail.co.uk/sciencetech/article-2093264/Forget-global-warming--Cycle-25-need-worry-NASA-scientists-right-Thames-freezing-again.html) that the Met Office and the University of East Anglia Climatic Research Unit, after taking data from nearly 30,000 stations around the world, have found that the earth stopped warming in 1997. The report suggests we are headed toward a new solar cycle, Cycle 25, which NASA scientists have predicted will be significantly cooler than Cycle 24 which we are in now. This data largely contradicts the accepted theory among the public that carbon dioxide pollution is causing global warming and even proposes that we are actually heading toward global cooling.¶ I share the same frustration in the political and scientific community that the sixteen scientists express. Why did we all hop on board the global warming bandwagon started by politicians when the scientific community didn’t back it? Since 1998, 31,000 scientists have signed a[petition](http://www.oism.org/pproject/)agreeing with the fact that there is no scientific evidence or consensus that man-made global warming exists while the Intergovernmental Panel on Climate Change (IPCC) has the support of only 2,500 scientists. Yet, for some reason it is accepted that global warming is scientifically undeniable.¶ Part of this is due to Al Gore’s 2006 documentary, An Inconvenient Truth, which has championed the cause to stop global warming and was shown throughout America including in classrooms. Gore dramatized the effects of carbon dioxide on climate change and some say he[even fabricated](http://newsbusters.org/blogs/noel-sheppard/2008/04/22/abc-s-20-20-gore-used-fictional-film-clip-inconvenient-truth) the evidence shown in the film.¶ But, the 2007 documentary, The Great Global Warming Swindle, (which I am sure you have never heard of) received no such publicity despite the fact that its arguments against global warming were backed by scientists, academics, writers and environmentalists. The film's major point is that the [real data](http://www.greatglobalwarmingswindle.co.uk/co2_temperature.html) shows that carbon dioxide decrease or increase follows temperature decrease or increase -- not the other way around. The film cites that when the earth gets warmer, the ocean releases carbon dioxide and when the earth gets cooler, the ocean absorbs carbon dioxide.¶ It is [estimated](http://www.forbes.com/sites/larrybell/2011/08/23/the-alarming-cost-of-climate-change-hysteria/) that we have spent around $106.7 billion of taxpayer money from 2003-2010 to try to understand and “fix” global warming. And the spending doesn’t stop there. The same research shows the government has proposed to spend around $1.4 billion in 2012 alone on climate change issues. The fact of the matter is we are spending egregious amounts of money on an issue that there is no scientific evidence to back.

### AT Warming – No Impact

#### Consensus of experts agree that there is no impact to warming

Hsu 10

(Jeremy, Live Science Staff, July 19, pg. <http://www.livescience.com/culture/can-humans-survive-extinction-doomsday-100719.html>)

His views deviate sharply from those of most experts, who don't view climate change as the end for humans. Even the worst-case scenarios discussed by the Intergovernmental Panel on Climate Change don't foresee human extinction. "The scenarios that the mainstream climate community are advancing are not end-of-humanity, catastrophic scenarios," said Roger Pielke Jr., a climate policy analyst at the University of Colorado at Boulder. Humans have the technological tools to begin tackling climate change, if not quite enough yet to solve the problem, Pielke said. He added that doom-mongering did little to encourage people to take action. "My view of politics is that the long-term, high-risk scenarios are really difficult to use to motivate short-term, incremental action," Pielke explained. "The rhetoric of fear and alarm that some people tend toward is counterproductive." Searching for solutions One technological solution to climate change already exists through carbon capture and storage, according to Wallace Broecker, a geochemist and renowned climate scientist at Columbia University's Lamont-Doherty Earth Observatory in New York City. But Broecker remained skeptical that governments or industry would commit the resources needed to slow the rise of carbon dioxide (CO2) levels, and predicted that more drastic geoengineering might become necessary to stabilize the planet. "The rise in CO2 isn't going to kill people, and it's not going to kill humanity," Broecker said. "But it's going to change the entire wild ecology of the planet, melt a lot of ice, acidify the ocean, change the availability of water and change crop yields, so we're essentially doing an experiment whose result remains uncertain."

#### No impact to warming – history and scientific study prove

Jaworowski, Chairman of the Scientific Council of the Central Laboratory for Radiological Protection in Warsaw and former chair of the United Nations Scientific Committee on the Effects of Atomic Radiation, ‘08 (Professor Zbigniew, “Fear Propaganda,”<http://www.ourcivilisation.com/aginatur/cycles/chap3.htm>,

Doomsayers preaching the horrors of warming are not troubled by the fact that in the Middle Ages, when for a few hundred years it was warmer than it is now, neither the Maldive atolls nor the Pacific archipelagos were flooded. Global oceanic levels have been rising for some hundreds or thousands of years (the causes of this phenomenon are not clear). In the last 100 years, this increase amounted to 10 cm to 20 cm, (24) but it does not seem to be accelerated by the 20th Century warming. It turns out that in warmer climates, there is more water that evaporates from the ocean (and subsequently falls as snow on the Greenland and Antarctic ice caps) than there is water that flows to the seas from melting glaciers. (17) Since the 1970s, the glaciers of the Arctic, Greenland, and the Antarctic have ceased to retreat, and have started to grow. On January 18, 2002, the journal Science published the results of satellite-borne radar and ice core studies performed by scientists from CalTech's Jet Propulsion Laboratory and the University of California at Santa Cruz. These results indicate that the Antarctic ice flow has been slowed, and sometimes even stopped, and that this has resulted in the thickening of the continental glacier at a rate of 26.8 billion tons a year. (25) In 1999, a Polish Academy of Sciences paper was prepared as a source material for a report titled "Forecast of the Defense Conditions for the Republic of Poland in 2001-2020." The paper implied that the increase of atmospheric precipitation by 23% in Poland, which was presumed to be caused by global warming, would be detrimental. (Imagine stating this in a country where 38% of the area suffers from permanent surface water deficit!) The same paper also deemed an extension of the vegetation period by 60 to 120 days as a disaster. Truly, a possibility of doubling the crop rotation, or even prolonging by four months the harvest of radishes, makes for a horrific vision in the minds of the authors of this paper. Newspapers continuously write about the increasing frequency and power of the storms. The facts, however, speak otherwise. I cite here only some few data from Poland, but there are plenty of data from all over the world. In Cracow, in 1896-1995, the number of storms with hail and precipitation exceeding 20 millimeters has decreased continuously, and after 1930, the number of all storms decreased. (26) In 1813 to 1994, the frequency and magnitude of floods of Vistula River in Cracow not only did not increase but, since 1940, have significantly decreased. (27) Also, measurements in the Kolobrzeg Baltic Sea harbor indicate that the number of gales has not increased between 1901 a

# Waste Water Advantage

## Solvency

### Solvency – Can’t Solve Wastewater

#### Plan can’t solve large sources of wastewater

Bullis 12 (Kevin, Staff writer, “NASA Wants to Launch Floating Algae Farms” 4/11/12 MIT review http://www.technologyreview.com/news/427475/nasa-wants-to-launch-floating-algae-farms/)//EAZYE

The setup is meant to solve some of the difficulties with making inexpensive fuels from algae. Algae need fertilizer to grow quickly, and wastewater is an excellent source of that. But large sources of wastewater—big cities—don’t have the space needed for the artificial ponds that algae are typically grown in. Pumping the water to areas where land is cheap and plentiful is expensive and energy-intensive. Clear containers called photobioreactors might take up less space, but those, too, are expensive. A few years ago, Trent wondered if floating plastic bags could serve as relatively cheap bioreactors. They don’t need as much support as land-based ones—at least if they’re floating on protected bays. And they solve another major problem with conventional bioreactors, which get too hot from sitting in the sun, and require expensive cooling systems as a result. In Trent’s plastic bag system, the surrounding water helps keep the bags cool. But while it may solve some problems—and it’s far from clear that the bags will prove superior to ponds or other photobioreactors—the system creates others. Trent acknowledges, for example, that there will be an “enormous amount of plastic” to dispose of. The plastic could be recycled, although cleaning out the algae may be difficult. A better option may be reusing it, he suggests. For example, it could be used to replace the black plastic that many farmers in California cover their fields with to reduce weeds and evaporation. The approach will face several other challenges. Working in corrosive saltwater environments is very difficult. And it’s not clear how well the bags would survive storms.

### Solvency – Not Enough Wastewater/Nutrients

#### In the best case scenario, wastewater provides nutrients to only 1% of fuel for a city

Christi 13 (Yusuf, PhD, Professor in Biochemical engineering at Massey University. July 12th 2013. “Constraints to commercialization of algal fuels” http://www.tamu.edu/faculty/tpd8/BICH407/Chisti%202013%20Journal%20of%20Biotechnology.pdf)//EAZYE

Every large metropolis generates a significant quantity of domestic wastewater. Wastewater is once again attracting attention as a source of the N and P nutrients for producing algae (Kosaric et al., 1974; Woertz et al., 2009; Kumar et al., 2010; Christenson and Sims, 2011; Craggs et al., 2011). Unfortunately, algal fuels from wastewater can make only a minuscule contribution to the fuel supply. In a best case scenario, algal oil from wastewater can contribute at most 1% to the petroleum demand of a large US city. The wastewater produced by a city of 10 million could at best provide about 425,000 metric tons of algal oil annually. This estimate is based on the following: a per capita wastewater generation rate of 378 L d−1; a relatively high nitrogen content of 85 mg L−1 in the wastewater; a relatively high phosphorous content in the wastewater of 10 mg L−1 (8 mg L−1 would have been more realistic); 6.6% nitrogen by weight in typical algal biomass; 1.3% phosphorous by weight in typical algal biomass; a full bioavailability of P; a 40% by weight oil content in the biomass; an algal oil density of 887 kg m−3 (assumed to be the same as for palm oil); 1.25 L of algal oil being energetically equivalent to a liter of petroleum (Chisti, 2012); and an annual per capita petroleum consumption of nearly 3577 L in the United States. Only about 73% of the total US petroleum consumption goes to making the main transport fuels of gasoline, diesel and kerosene. Therefore, if algal oil is used to displace only the petroleum consumed for making transport fuels, up to 3% of the annual fuel requirements of a large city of 10 million could be provided using algae grown on wastewater produced by the city. Clearly, the nutrients in wastewater cannot supply any substantial amount of algal biofuels.

### SQ Solves Cleanup

#### Wastewater treatment is great now.

Gordon 12 (Ashley, staff writer, “Reusing Treated Wastewater Not So Bad: Report” 1/31/12 NBC LA http://www.nbclosangeles.com/news/local/Treated-Wastewater-LADWP-Report-National-Research-Council-137138033.html)//EAZYE

The idea of drinking wastewater of any kind may leave some with a bad taste in their mouth, but a report released Tuesday by the National Research Council says the health risks involved in such a practice are no higher than they are in existing water supplies. Of course, the report adds that wastewater would be treated for chemical and microbial contaminants before consideration as drinking water or for use in other industries. “Wastewater reuse is poised to become a legitimate part of the nation’s water supply portfolio given recent improvements to treatment processes,” said R. Rhodes Trussell, chair of the committee that wrote the study. Among several California agencies that sponsored the report was the Los Angeles Department of Water and Power, a department that has faced concerns for future water supply in an arid area with a growing population. The utility caught flack by critics in the past for what was termed a “toilet-to-tap” plan that may have had Angelenos sipping purified recycled water. Now, as the department reconsiders its rate structure, the idea it has tread lightly in reintroducing may once again be on the table. A general manager at the DWP told the LA Times that it was encouraged by the report, “which once again underscores the importance of using recycled water to augment existing water resources.” About 12 billion gallons of municipal wastewater is discharged to an ocean or estuary daily, amounting to 6 percent of the total U.S. water supply, according to the 363-page report. It was noted that some communities have already implemented inexpensive water reuse projects.

## Impact Defense

### AT Wastewater – Natural Checks

#### There are natural checks that minimize wastewater runoff

**Swanson 9** (Kent, Master’s in Community @ Regional Planning, http://www.practicalenvironmentalist.com/gardening/10-steps-to-a-healthy-ocean-protecting-our-oceans-from-pollution.htm, JM)

[Biosystems are nature’s utilities](http://www.bagheera.com/inthewild/classroom/class_extinction_why.htm) – they desalinate water, absorb carbon, liberate nutrients from the ground, and provide other services free of charge. The plants and animals that make up these systems are often treated as commodities, but killing the goose that lays golden eggs will only put food on the table for a day. Protecting biosystems can pay dividends for years to come. Forests are an essential buffer for the oceans. Old growth trees neutralize the pH of rain and absorb harmful chemicals before they reach the ocean. Trees that grow in estuaries and along riverways are especially important, but those areas also face increased development pressure and they are easy for loggers to access. Shoreline habitat is being destroyed to build [giant shrimp farms](http://www.gourmet.com/magazine/2000s/2007/03/shrimp) and resort hotels. Luckily, there are now sustainable forestry and aquaculture options available. [Sustainable logging](http://www.spi-ind.com/html/forests_sustainable.cfm) allows limited harvesting of resources without destroying the natural processes that we benefit from. The next time you buy lumber or land, do some research and check for [certifications of sustainability](http://www.enn.com/top_stories/article/9445).

### AT Waterborne Diseases – SQ Solves

#### Status quo monitoring solves for the spread of waterborne diseases

Gunther Craun, 2012, SCIFLO Public Health, “health risks from water and new challenges for the future,” <http://www.scielosp.org/scielo.php?pid=S0021-25712012000400011&script=sci_arttext>

The US waterborne disease outbreak surveillance system has largely been successful because of the continued cooperation of public health professionals at the EPA, CDC and various state agencies. This cooperation is necessary because the responsibility for establishing national drinking water regulations and conducting the accompanying health effects and water treatment research resides within the EPA, whereas the responsibility for disease surveillance resides within CDC. In addition, most states have a similar arrangement where environmental protection agencies are responsible for ensuring the safety of drinking water while state public health agencies are responsible for disease surveillance and outbreak investigation. Even when both of these responsibilities reside within the same state agency, several different bureaus may be involved. In addition, outbreak investigation requires professionals with differing technical expertise, some of which may be provided from sources outside the government. Continued leadership at the federal and state levels is necessary to ensure that outbreaks are detected, investigated, and reported.

### AT Dead Zones – Algae Causes Dead Zones

#### Algae production causes eutrophication, which creates dead zones

National Research Council, 12

(National Research Council, Sustainable Development of Algal Biofuels in the United States,” Page 159, Published in 2012, http://www.qibebt.cas.cn/xscbw/yjbg/201211/P020121106350992249909.pdf)

Large-scale algae cultivation requires the provision of large quantities of nutrients, especially nitrogen and phosphorus, to ensure high yield (see section Nutrients in Chapter 4). Even where nitrogen and phosphorus are not in oversupply, the total nutrient concentrations in algal biomass will be high. Although accidental release of cultivation water into surface water and soil is unlikely, such an event could lead to eutrophication of downstream freshwater and marine ecosystems, depending on the proximity of algal ponds to surface and groundwater sources. Eutrophication occurs when a body of water receives high concentrations of inorganic nutrients, particularly nitrogen and phosphorus, stimulating algal growth and resulting in excessive algal biomass. As the algae die off and decompose, high levels of organic matter and the decomposition processes deplete oxygen in the water and result in anoxic conditions (Smith, 2003; Breitburg et al., 2009; Rabalais et al., 2009; Smith and Schindler, 2009). In some cases, eutrophication-induced changes could be difficult or impossible to reverse if alternative stable states can occur in the affected ecosystem (Scheffer et al., 2001; Carpenter, 2005).

### Pollution Turn

#### The production of algae biofuels will destroy local ecosystems

Giersbergen, 14

(Jos van Giersbergen, Jos graduated as an engineer and reports on new and green technology, From Quarks to Quasars, “A Truly Green Revolution: Turning Algae into Biofuel,” January 22, 2014 http://www.fromquarkstoquasars.com/a-truly-green-revolution-turning-algae-into-biofuel/)

Some types of algae are more efficient than others. When pinpointing one specific thing, the lipid content seems the largest contributing factor. Depending on the content, a kilo will either power an SUV or mow a small lawn. Unfortunately, the most effective forms of algae are also the most exotic species of algae, and those generally don’t multiply fast enough to suit our purposes. Plus, algae is wet, very wet. So wet, in fact, that the only real way to use it as a viable source of energy is to dry it out… at massive costs. Growing them and drying them in large enough quantities is proving to be a major hurdle. To provide the U.S. with enough algae to support their daily appetite, it would require an amount of algae equal in surface area to the state of Maryland; however, that’s still ten times smaller than what would be needed for providing enough biodiesel from corn or soy; that would have to be half the landarea of the U.S.A. Additionally, even if we were able to grow that much algae in order to meet out needs, it would be problematic as Algae blooms are quite destructive. They can literally choke the life from a region; however, most worrying are the toxic species. If it becomes profitable to tinker with the genome of one of those, a corporate sense of ethics might be all that stands between us and environmental pandemonium. So algae blooms are no joke. Even if the species involved is not toxic (and most of them are not), they can still do plenty of harm. Simply blocking sunlight will stifle the growth of, or even kill, the marine flora (which forms the basis of many underwater food chains). At night, algae will use more oxygen than they produce (no photosynthesis). Compounding that is the fact that, as algae die and decompose, they use up even more oxygen. In short, the day that there is an algae bloom is not a good day to be a fish. In addition, to turn algae into oil, you have to be able to grow enough of them to begin with, and most studies show that contamination with other organics would severely limit productivity.

### Ocean Destruction Inevitable

#### Ocean destruction inevitable – mass extinction already begun, and emission lag guarantees further acidification

Harvey 13 (Fiona Harvey, award winning environmental journalist for the Guardian, “Rate of ocean acidification due to carbon emissions is at highest for 300m years” October 2, 2013, http://www.theguardian.com/environment/2013/oct/03/ocean-acidification-carbon-dioxide-emissions-levels)

The oceans are becoming more acidic at the fastest rate in 300m years, due to carbon dioxide emissions from burning fossil fuels, and a mass extinction of key species may already be almost inevitable as a result, leading marine scientists warned on Thursday.¶ An international audit of the health of the oceans has found that overfishing and pollution are also contributing to the crisis, in a deadly combination of destructive forces that are imperilling marine life, on which billions of people depend for their nutrition and livelihood.¶ In the starkest warning yet of the threat to ocean health, the International Programme on the State of the Ocean (IPSO) said: "This [acidification] is unprecedented in the Earth's known history. We are entering an unknown territory of marine ecosystem change, and exposing organisms to intolerable evolutionary pressure. The next mass extinction may have already begun." It published its findings in the State of the Oceans report, collated every two years from global monitoring and other research studies.¶ Alex Rogers, professor of biology at Oxford University, said: "The health of the ocean is spiralling downwards far more rapidly than we had thought. We are seeing greater change, happening faster, and the effects are more imminent than previously anticipated. The situation should be of the gravest concern to everyone since everyone will be affected by changes in the ability of the ocean to support life on Earth."¶ Coral is particularly at risk. Increased acidity dissolves the calcium carbonate skeletons that form the structure of reefs, and increasing temperatures lead to bleaching where the corals lose symbiotic algae they rely on. The report says that world governments' current pledges to curb carbon emissions would not go far enough or fast enough to save many of the world's reefs. There is a time lag of several decades between the carbon being emitted and the effects on seas, meaning that further acidification and further warming of the oceans are inevitable, even if we drastically reduce emissions very quickly. There is as yet little sign of that, with global greenhouse gas output still rising.

#### Alt cause: overfishing, technology, and trash dumping destroying the ocean

Labbe 14 (Mark Labbe, journalist for the Westside Story, international news agency, “Our oceans are almost destroyed by overfishing, pollution” June 26, 2014 http://www.thewestsidestory.net/2014/06/26/13473/oceans-almost-destroyed-overfishing-pollution/)

The Global Ocean Commission recently released a report which implies that the world’s oceans are being destroyed. This is not happening because of natural forces or random events, but it is happening because of human interference and pollution.¶ “Our ocean is in decline. Habitat destruction, biodiversity loss, overfishing, pollution, climate change and ocean acidification are pushing the ocean system to the point of collapse,” researchers wrote in the report. Part of the reason why there is so much damage being done to our oceans is because of technological advances. New and better ways of fishing makes it easier for people to wipe out populations of fish, essentially destroying delicate ecosystems by making them unbalanced.¶ Not only that, but pollution from these technologies is also causing issues. Huge amounts of garbage, fuel, and plastic are being dumped into oceans, and it is killing off entire species. It also lays waste to many types of vegetation, which can lead to food shortages.¶ The report is urging governments all across the world to create more laws to protect the oceans.¶ “There are clear economic incentives for both the public and private sectors to take their responsibilities in the high seas more seriously,” the report says.

#### Mass extinctions in the ocean are inevitable

Wright 14 (Kimberly Wright, journalist for Raycom News Network, “Scientists warn of mass extinctions in world's oceans” Jan 6, 2014 http://www.americanownews.com/story/23596939/scientists-warn-of-mass-extinctions-in-worlds-oceans)

(RNN) - A team of marine scientists issued a dire warning Oct. 3 on the state of the world's oceans. They say that mass extinctions may already be inevitable.¶ A report issued by the International Programme on the State of the Ocean and the International Union for Conservation of Nature states that the world's oceans are experiencing decreasing oxygen levels, warming and acidification as a result of several stressors, including climate change, pollution and overfishing.¶ "The health of the ocean is spiraling downwards far more rapidly than we had thought," said Alex Rogers, the scientific director of IPSO. "We are seeing greater change, happening faster, and the effects are more imminent than previously anticipated. The situation should be of the gravest concern to everyone since everyone will be affected by changes in the ability of the ocean to support life on Earth."¶ These factors have serious consequences for marine life, as temperature, chemistry, nutrient and oxygen supply all are necessary for the oceans to support an abundance of marine life.¶ If the amount of carbon dioxide absorption remains at its current level, by about 2030 or 2050, the carbon dioxide content in the oceans is expected to cause coral reefs to erode and lead to the extinction of some species.¶ Coral reefs provide shelter and protection for several species of fish, according to Texas A&M University, as well as helping to control the level of carbon dioxide in the oceans.¶ A United Nations climate change panel report released in late September noted that the ocean is absorbing much of the increasing heat from the changing climate. The International Programme on the State of the Ocean's report noted that the warming of the world's oceans will have negative effects, including further reducing oceanic oxygen levels.¶ Melting Arctic ice will also cause more methane to be released into the atmosphere, contributing to climate change. Seasonal ice zones will continue to shrink, with Arctic summer sea ice disappearing by about 2037.¶ "Potential knock-on effects of climate change in the ocean, such as methane release from melting permafrost, and coral dieback, mean the consequences for human and ocean life could be even worse than presently calculated," the report noted.

### AT Ocean Acidification – Resilient

#### Oceans can easily survive acidification

**Ridley 10** (Matt Ridley, Doctor of Philosophy in Zoology, June 15, http://www.thegwpf.org/the-observatory/1106-matt-ridley-threat-from-ocean-acidification-greatly-exaggerated.html, JM)

Lest my critics still accuse me of cherry-picking studies, let me refer them also to the results of Hendrikset al. (2010, Estuarine, Coastal and Shelf Science 86:157). Far from being a cherry-picked study, this is a massive meta-analysis. The authors observed that `warnings that ocean acidification is a major threat to marine biodiversity are largely based on the analysis of predicted changes in ocean chemical fields’ rather than empirical data. So they constructed a database of 372 studies in which the responses of 44 different marine species to ocean acidification induced by equilibrating seawater with CO2-enriched air had been actually measured. They found that only a minority of studies demonstrated `significant responses to acidification’ and there was no significant mean effect even in these studies. They concluded that the world's marine biota are `more resistant to ocean acidification than suggested by pessimistic predictions identifying ocean acidification as a major threat to marine biodiversity’ and that ocean acidification `may not be the widespread problem conjured into the 21st century…Biological processes can provide homeostasis against changes in pH in bulk waters of the range predicted during the 21st century.’ This important paper alone contradicts Hoegh-Gudlberg’s assertion that `the vast bulk of scientific evidence shows that calcifiers… are being heavily impacted already’. In conclusion, I rest my case. My five critics have not only failed to contradict, but have explicitly confirmed the truth of every single one of my factual statements. We differ only in how we interpret the facts. It is hardly surprising that my opinion is not shared by five scientists whose research grants depend on funding agencies being persuaded that there will be a severe and rapid impact of carbon dioxide emissions on coral reefs in coming decades. I merely report accurately that the latest empirical and theoretical research suggests that the likely impact has been exaggerated.

#### Adaptation checks ocean acidification impact

NIPCC 12 “The Potential for Adaptive Evolution to Enable the World’s Most Important Calcifying Organism to Cope with Ocean Acidification,” Staff. NIPCC, Nongovernmental International Panel on Climate Change. 18 July 2012 (http://www.nipccreport.org/articles/2012/jul/18jul2012a3.html)

In an important paper published in the May 2012 issue of Nature Geoscience, Lohbeck et al. (2012) write that "our present understanding of the sensitivity of marine life to ocean acidification is based primarily on short-term experiments," which often depict negative effects. However, they go on to say that phytoplanktonic species with short generation times "may be able to respond to environmental alterations through adaptive evolution." And with this tantalizing possibility in mind, they studied, as they describe it, "the ability of the world's single most important calcifying organism, the coccolithophore Emiliania huxleyi, to evolve in response to ocean acidification in two 500-generation selection experiments."¶ Working with freshly isolated genotypes from Bergen, Norway, the three German researchers grew them in batch cultures over some 500 asexual generations at three different atmospheric CO2 concentrations - ambient (400 ppm), medium (1100 ppm) and high (2200 ppm) - where the medium CO2 treatment was chosen to represent the atmospheric CO2 level projected for the beginning of the next century. This they did in a multi-clone experiment designed to provide existing genetic variation that they said "would be readily available to genotypic selection," as well as in a single-clone experiment that was initiated with one "haphazardly chosen genotype," where evolutionary adaptation would obviously require new mutations. So what did they learn?¶ Compared with populations kept at ambient CO2 partial pressure, Lohbeck et al. found that those selected at increased CO2 levels "exhibited higher growth rates, in both the single- and multi-clone experiment, when tested under ocean acidification conditions." Calcification rates, on the other hand, were somewhat lower under CO2-enriched conditions in all cultures; but the research team reports that they were "up to 50% higher in adapted [medium and high CO2] compared with non-adapted cultures." And when all was said and done, they concluded that "contemporary evolution could help to maintain the functionality of microbial processes at the base of marine food webs in the face of global change [italics added]."¶ In other ruminations on their findings, the marine biologists indicate that what they call the swift adaptation processes they observed may "have the potential to affect food-web dynamics and biogeochemical cycles on timescales of a few years, thus surpassing predicted rates of ongoing global change including ocean acidification." And they also note, in this regard, that "a recent study reports surprisingly high coccolith mass in an E. huxleyi population off Chile in high-CO2 waters (Beaufort et al., 2011)," which observation is said by them to be indicative of "across-population variation in calcification, in line with findings of rapid microevolution identified here."

#### Marine life is resilient – rapid reproduction

**ITOPF 10** (The International Tanker Owners Federation Limited, February 10, http://www.itopf.com/marine-spills/effects/recovery/, JM)

Marine organisms have varying degrees of natural resilience to changes in their habitats. The natural adaptations of populations of animals and plants to cope with environmental stress, combined with their breeding strategies, provide important mechanisms for coping with the daily and seasonal fluctuations in their habitats and for recovering from predation and other stochastic events. Some natural phenomena can be highly destructive. The short-term power of hurricanes and tsunamis can easily be appreciated, as can the damage they cause. The cyclical El Niño phenomenon has major long-term consequences for marine organisms, seabirds and marine mammals throughout the entire Pacific Ocean. Organisms suffer under such onslaughts, but after what is often severe disruption and widespread mortality, the marine populations re-establish themselves over a period of time and this process constitutes natural recovery. An important reproductive strategy for many marine organisms is the production of vast numbers of eggs and larvae which are released into the plankton and are widely distributed by currents. This mechanism has evolved to take maximum advantage of available space and resources in marine habitats and to deal with e.g. predation. In some cases, only one or two individuals in a million actually survive through to adulthood. A less common reproductive strategy that is generally restricted to long-lived species that do not reach sexual maturity for many years is to produce relatively few, well-developed, offspring. These species are better adapted to stable habitats and environments and as a result, their populations are likely to take much longer to recover from the pressures of localised mortality e.g. the effects of an oil spill. Whilst there may be considerable debate over what constitutes recovery, there is a widespread acceptance that natural variability in systems makes getting back to the exact pre-spill condition unlikely, and most current definitions of recovery focus on the re-establishment of a community of plants and animals which are characteristic of the habitat and are functioning normally in terms of biodiversity and productivity.

### AT Ocean Acidification - Inevitable

#### Ocean acidification is inevitable – only hope now is adaptation

Interagency Working Group on Ocean Acidification 14 (Interagency Working Group on Ocean Acidification, Subcommittee on Ocean Science and Technology, Committee on Environment, Natural Resources, and Sustainability, and the National Science and Technology Council, “Strategic Plan for Federal Research and Monitoring of Ocean Acidification” March 2014, http://www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/iwg-oa\_strategic\_plan\_march\_2014.pdf)

Some degree of further ocean acidification is inevitable regardless of how effective mitigation efforts are. ¶ Adapting to or coping with the resulting impacts will become necessary for some parts of the population and ¶ sectors of the economy. Adaptation to changing environmental conditions is not a new concept. Creating ¶ crops that are resistant to drought, disease, and pests is one example of a human system adapting to adverse ¶ environmental conditions; however, the changes we are likely to see in atmospheric and ocean chemistry ¶ present a challenge on a larger scale. An early example of adaptation to ocean acidification is the response of ¶ shellfish growers along the Pacific Coast. In recent years, several oyster hatcheries have experienced a near complete collapse of production. A partnership between industry, academia and federal scientists led to the ¶ discovery that high CO2 (and a resulting low mineral saturation state) in the hatchery waters was causing the ¶ decline. As a result, hatcheries are now monitoring water quality conditions very closely and have developed ¶ adaptation strategies including closing the intake valves to the hatcheries when corrosive waters are detected ¶ and other manipulations of the chemistry to reduce its corrosiveness before it reaches the growing oysters. ¶ Other adaptive strategies may include breeding programs that support stocks of oysters that are genetically ¶ able to adapt (see Ocean Margin Ecosystems Group for Acidification Studies for more information). Adaptation is a risk-management strategy that has costs and is not foolproof. The effectiveness of any specific adaptation requires consideration of the expected value of the avoided damages against the costs of implementing ¶ the adaptation strategy (Easterling et al. 2004; Metz et al. 2007). Additionally, ocean acidification adaptation ¶ strategies should, if possible, compliment strategies developed for other climate and ecosystem stressors (e.g., ¶ NOAA 2010b).

# Offcase

## Politics

### Link – OMEGA

#### Expansion of OMEGA triggers political fights

Lauren De Vore, 11/19/2009, LLNL Community News, “Algae could turn tide for biofuel production,” <https://newsline.llnl.gov/_rev02/articles/2009/nov/11.13.09-algae.php>

“There’s biology — what strains of algae are best at producing oil, and can we make them grow in the system? There’s engineering — not just plastic bags in the ocean, but the whole system design and all of the logistics involved in maintaining such a system. There’s the economic angle — OMEGA will require new infrastructure. And of course there are the environmental issues, including policies, politics and public acceptance.”¶ Despite the magnitude of the undertaking, Trent was adamant about the need to push ahead. “It’s clear that something has to be done and done soon about our energy problems. Things are not sustainable the way they are now.¶ “OMEGA may not be the best way to go, but we need to investigate it to determine its technical and economic feasibility. We need to try other new ideas as well. If we wait too long, the environment will be the first thing to go as we do whatever it takes just to feed the growing population.”

### Link – Algae Biofuels

#### Prefer our evidence; even if algae used to be bipartisan, it has become politicized

Parker 12 (Alex M. Parker, journalist for the US News and World Report, “Algae Amendment Puts Biofuels Back in Energy Debate” March 13, 2012, http://www.usnews.com/news/articles/2012/03/13/algae-amendment-puts-biofuels-back-in-energy-debate)

The cultivation of algae to create or enhance biofuels has, in the past, been relatively non-controversial. But the issue became politicized quickly after President Barack Obama mentioned it as a component of his energy platform last month.¶ Mocking the idea as a pie-in-the-sky response to the real-life problem of high gas prices, the GOP presidential candidates have made it a regular laugh line on the campaign trail. Former House Speaker Newt Gingrich has taken to calling Obama "President Algae."¶ On Capitol Hill, the algae-as-fuel idea has quickly become a symbol of wasteful government overreach among conservative Republicans.¶ "Algae will be a bad sequel to ethanol," says John Hart, spokesman for Oklahoma Sen. Tom Coburn, who has lead charges to eliminate tax preferences or federal standards which promote the use of corn-based ethanol.

#### Republicans dislike use of algae biofuel - HASC Defense bill proves.

**AIM 12**

(http://www.algaeindustrymagazine.com/the-politics-of-algae-continued/¶ The Politics of Algae, continued…¶ May 15, 2012¶ AlgaeIndustryMagazine.com, Date Accessed: 6.28.14)//BSpencer

**Two articles out this week deftly explore the dilemma the algae, and for that matter the entire bio fuels, industry finds itself – in the wake of the House Armed Services Committee (HASC) recently passing the 2013 Defense Authorization bill** (H.R. 4130) **banning the Defense Department from making or buying an alternative fuel that costs more than traditional fossil fue**l.¶ While the military itself has been an outspoken supporter of the need to have more reliable and controllable fuel sources, the **Republican-dominated HASC feels the greater need to bring down costs, especially the premiums that the military has been paying for early-stage green fuels; costs that have helped to cover some of the bio fuels industry’s development**.¶ In Eric Beidel’s piece in National Defense Magazine he calls it the classic chicken and the egg conundrum, **where the developing bio-fuels industry needs the military to buy big, providing a demand signal that could help reduce prices**.

#### Republicans hate the plan, attack Obama for it

McAuliff 12 (Michael McAuliff, senior congressional reporter for the Huffington Post, “Algae Biofuel Proposal, Now Mocked By Republicans, Used To Have Their Support” February 28, 2012 http://www.huffingtonpost.com/2012/02/28/mitch-mcconnell-mocks-pre\_n\_1307862.html)

Capitol Hill Republicans mounted an all-out offensive against President Obama's energy initiatives Tuesday, even mocking him for an idea many of them used to like: using algae to create biofuel. "Over the past few weeks the American people have begun to feel the painful effects of President Obama's energy policy," Senate Minority Leader Mitch McConnell declared in a Senate floor speech that ridiculed an energy plan Obama detailed last week, which included the use of biofuel sources such as algae. "As millions of Americans groaned at the rising cost of a gallon of gasoline, the president took algae as a substitute for gas. Algae as a substitute for gas," McConnell said in apparent disbelief. "I think the American people realize that a president who's out there talking about algae -- algae! -- when we're having to choose between whether to buy groceries or fill up the tank is the one who is out of touch," McConnell added, arguing that the way to bring down gas prices is to drill for more oil. "Americans get this issue," McConnell said. "They get that we need to increase oil production right here at home, not simply rely on pipe dreams -- pipe dreams -- like algae or by wasting billions of taxpayer dollars on more failed clean energy projects." McConnell was followed by Sen. Kay Bailey Hutchison (R-Texas), who suggested Obama's plans were no plans at all. "What the president does favor is the Saudis increasing oil production, and increased use of solar, wind and algae here at home," she said. "Does that really substitute for an energy policy?"

### Link – Costs PC

#### Investments and tax breaks for biofuels cost political capital

Naylor 12 (Rosamond Naylor, Director of the Center of Food Security and the Environment, William Wrigley Senior Fellow, Professor of Environmental Earth System Science at Stanford University, “Biofuels, Rural Development, and the Changing Nature of Agricultural Demand” April 11, 2012, https://woods.stanford.edu/sites/default/files/files/BiofuelsPaper.pdf)

The third and final theme draws on these points and addresses the question: Given the ¶ uncertainties and public sector costs surrounding the development of liquid biofuels, ¶ should developing countries facing high rates of food and energy insecurity invest in the ¶ industry? There is no universal answer to this question; each country must evaluate its ¶ own economic and resource situation, and its institutional capacity. This evaluation must ¶ be done with skill and great care, because the stakes for rural development, hunger, ¶ resource depletion, and inequality are high. Adopting a strategy for biofuel growth as a ¶ means of stimulating the agricultural economy, addressing domestic transportation fuel ¶ needs, and enhancing foreign exchange reserves will require the creation of well functioning supply chains that can generate economies of scale. To date, small isolated ¶ plants with new sources of feedstocks (e.g., jatropha) have thus far been too costly. ¶ Public investments in agricultural productivity and infrastructure, as well as fuel ¶ mandates and tax exemptions for private companies that are needed to build supply ¶ chains and ensure long-run demand for biofuels, will have large opportunity costs in ¶ terms of fiscal expenditures, land and water resources, and political capital.

## Military CP

### 1NC

#### Text: The Department of Defense should substantially increase its procurement of algae-based biofuels produced in offshore membrane enclosures in the oceans.

#### Military procurement ensures commercialization – the Navy can drive economics of scale by providing market certainty

Lieutenant Alaina Chambers (US Navy) and Steve Yetiv, 2011, Naval War College Review, “The Great Green Fleet,” <https://www.usnwc.edu/getattachment/72d7de2c-b537-4466-9b4b-809c205d1747/The-Great-Green-Fleet--The-U-S--Navy-and-Fossil-Fu>

Though some may question whether the acquisition-reform initiative could¶ damage its predictability as a customer, the Navy will still be attractive to potential¶ contractors. Its current budget allots about $200 million to energy projects¶ and research and development.23 Secretary Mabus has stated that the Department of the Navy has “4.4¶ million acres of land, 72,500 buildings, 50,000 commercial vehicles, 3,800 aircraft,¶ 286 ships, and more than 900,000 employees.”24 Each ship requires about¶ ninety thousand barrels of fuel annually.¶ The required technology for becoming less dependent on oil exists but is not¶ fully developed. Some of this technology is designed for increasing the ability of¶ electricity to offset the use of fossil fuels, which, at present, is not significant. Increasing¶ this ability translates chiefly into replacing oil with electricity where¶ most of the world’s oil is used—in transportation. Moving to a fleet of electric¶ and hybrid vehicles could accomplish this goal.¶ Also, if history is any indication, the “technological curve” should produce¶ higher-quality, lower-cost technologies over time. That has certainly been the¶ case with semiconductor-based consumer products and with internet routers¶ and switches. That is important because as long as oil remains relatively cheap,¶ such technologies may not be feasible to pursue without government subsidies¶ or market “triggers,” such as higher taxes on fossil fuels. This is where a customer¶ like the Department of the Navy could play a role, serving as a predictable customer of green technologies,¶ with a long-term demand.25 Even a comparatively small amount of money¶ could help stimulate a growing industry, especially with other branches of the¶ military following suit. Gradually larger military orders could drive innovation¶ and foster economies of scale. Once capable of filling bulk orders at competitive¶ cost, these burgeoning industries would be in a position to bid for private-sector¶ fuel contracts.

### Solvency – Commercialization

#### The military is a huge driving of energy innovation – that spills over to the civilian sector

Velandy 14 (Siddhartha M. Velandy Major in the United States Marine Corps Reserve) Jun 10, 2014 “THE ENERGY PIVOT: HOW MILITARY-LED ENERGY INNOVATION CAN CHANGE THE WORLD” <http://vjel.vermontlaw.edu/files/2014/06/Velandy_Forprint.pdf>

This global presence takes a tremendous amount of energy to fuel. The Defense Department is the single largest energy consumer in the ¶ nation, responsible for just under two percent of total consumption.20 In ¶ 2012, the U.S. military used 4.3 billion gallons of fuel at a cost of ¶ approximately $20 billion.21 Oil is a globally traded commodity. Due to ¶ spikes in the global market, in 2012 alone, the Department of Defense had $3 billion in unbudgeted fuel costs. Energy is an essential element of the United States’ global presence, and for precisely that reason, the Department of Defense is at the center of energy innovation. Military leaders, informed by the longest sustained ¶ conflict in American history, are finding that military forces are far more ¶ agile as energy efficiency increases and the tether of liquid fuel diminishes. ¶ This Defense-led energy innovation, managed effectively, can be shared through both formal treaty mechanisms and informal networks to globalize the demand for unconventional energy and drive the development of new technology and effective regulation. Our allies will be strong partners, able to localize the benefits of a more efficient and lethal military force. The global demand and innovation will spill over into the commercial market, making new technology available to private citizens across the globe. This defense-led energy innovation has the power to unite the once bespoke approaches to address climate change, energy policy, and national security. The unconventional energy arms race will result in a more efficient fighting force, more diverse sources of energy, and a more stable world order. History provides great instances of defense-driven innovation leading greater change.

#### Military procurement of biofuels encourages private sector investment

National Journal “Navy’s Use of Biofuels Could Trigger Private-Sector Adoption”

http://www.nationaljournal.com/daily/navy-s-use-of-biofuels-could-trigger-private-sector-adoption-20130815

The Navy's use of advanced biofuels could help spur private-sector investment, said Dennis McGinn, President Obama's newly confirmed assistant secretary of the Navy for energy, installations, and environment.¶ "The private-sector benefits are the military's ability to do some pretty good analysis, to manage risk, and to introduce innovative materials and innovative processes," said McGinn, who was confirmed by the Senate earlier this month before the congressional recess. "It significantly lowers the barrier of entry to new industries and new technologies."¶ From medical devices to space technology, the Pentagon has often been an incubator for the private sector. McGinn said he's going to work to make sure it's the same in the renewable-energy sphere, and especially for biofuels.¶ "It can have a catalytic effect for large consumers of transportation," said McGinn, who stepped down recently from his post as president of the American Council on Renewable Energy when the Obama administration courted him for this position.

#### Military investments in biofuels drive commercialization

Marvin 12

(James Marvin, 11.26.12, Truman National Security Project, “Biofuels Yield Military, Economic Dividends”, http://trumanproject.org/doctrine-blog/biofuels-yield-military-economic-dividends/)

Every day around the world, technologies that are developed by the military help our troops carry out missions that keep America safe. But beyond strengthening our national security and giving Americans peace of mind, military investments in technology yield another dividend — economic growth. And a new report from Environmental Entrepreneurs (E2) shows just how big that growth can be. According to the report, the military’s advanced biofuels initiatives will directly generate between $10 billion and $20 billion of economic activity in the private sector by 2020. Military biofuels investments also will create more than 14,000 new, unique jobs in diverse sectors in eight years. Farmers will grow crops that provide biofuels feedstock but don’t compete with our food supply. Construction workers will help build new biofuels plants, or retrofit old oil refineries. And truck drivers and railroad engineers will transport fuel to military bases all across the U.S. The Navy and Air Force have mapped out the most ambitious biofuels plans. Their goal is to replace half their consumption of petroleum-based liquid fuels with alternative fuels over the next decade — requiring about 770 million gallons of biofuels production capacity per year, the E2 report found. To meet this target, the nascent biofuels industry will have to expand. This will be an expensive effort, and initial investments by the military will create market certainty, eventually attracting private capital that will finance biorefinery construction and drive development of new technologies.

#### Military investment brings down biofuel cost

Weiss 11

(Daniel J. Weiss, May 25, 2011, Center for American Progress, “The House Wants to Slow the Military’s Clean Energy March”, http://americanprogress.org/issues/green/news/2011/05/25/9623/the-house-wants-to-slow-the-militarys-clean-energy-march/)

Secretary Mabus believes that the U.S. military should “take the lead” and that “the Navy can be a market” in biofuels use, which will help speed the development and commercialization of advanced biofuels for both military and civilian use. The Army notes that a military investment in clean energy technologies “creates new products, new business opportunities for a ready market. … [it] reduces R&D cost and risk of entry for commercial businesses.” And early adoption of these technologies by the Defense Department provides certainty to investors that there will be a market for new products.

#### CP could drastically reduce biofuel costs

Mick, 11

(Jack Mick, Daily Tech, “Military Biofuel Costs Slashed Thanks to Massive Navy Purchase,” December 7, 2011, <http://www.dailytech.com/Military+Biofuel+Costs+Slashed+Thanks+to+Massive+Navy>+

Purchase/article23454.htm)

For better or worse the U.S. military is trying to fight an "army of one" campaign to switch its massive fuel consumption base to domestic biofuels, safeguarding itself from foreign volatility. And despite some small bills to the U.S. taxpayers the push appears to be working. Biofuels work pretty much like any production industry -- you produce more, and price per unit drops. Back in October 2010 the Navy purchased 20,055 gallons of algae biofuel at a whopping cost of $424/gallon. At the time that was one of the biggest U.S. purchases of a (non-corn ethanol) biofuel to date. Fast-forward a year and the Navy is back at it. It's spent a reported $12M USD to get 450,000 gallons of biofuel. The bad news? The fuel cost works out to around $26.67 per gallon -- around 6 to 8 times as much as traditional gas. The good news? The cost per gallon has plunged by a jaw-dropping factor of 15.9. While the incredible cost reduction is unlikely to continue at its current pace, the purchase validates something some national security and environmental advocates have been emphasizing all along -- if you produce more, costs will drop.

### Solvency – Procurement

#### Military procurement solves – it acts as a first-mover and creates huge demand

Sarah Light, December 2013, (Assistant Professor of Legal Studies and Business Ethics), The Wharton School, University of Pennsylvania, “The military-environmental complex,” <http://ppi.wpengine.netdna-cdn.com/wp-content/uploads/2012/11/issue-brief_V1_N12.pdf>

The exceptional alignment between the military mission and the need to conserve energy, address climate change, and develop renewables, brings equally exceptional potential: for stimulating the development of new technologies, providing large-scale commercial support for existing technologies, and helping to drive behavioral changes on a grand scale. Policymakers need to think carefully about how to harness this alignment, and how cooperation between the military and the private sector can advance these ends. If nurtured properly, the military’s extensive undertaking to improve its sustainable energy use and reduce demand for fossil-fuel-derived energy both on the battlefield and in permanent installations, in which the military’s interests are intertwined with those of Congress, the President, and the private sector—what I call the Military-Environmental Complex—has the potential to become one important tool in the regulatory toolkit to combat climate change.¶ Military stimulation of technological development during has deep roots. At its height during the twentieth century, military needs played a major role in driving the development of new technologies such as semiconductors, the global positioning system, the Internet, and computers that not only transformed war fighting, but the civilian realm as well. Both military-driven innovation (R&D) and procurement from the private sector drove this innovation. As a first user of new environmental technologies, the military not only can help evaluate their effectiveness, but by its very size creates a needed market to simulate innovation, as it has done in the past with aircraft, electronics, and the internet. The mere fact that a project supports military interests—rather than general commercial interests—may drive support among other institutional players who may feel more strongly connected to the value of protecting national security than other values such as energy independence or environmental protection. Moreover, the DoD’s exceptional hierarchical nature allows its leadership to consider the importance of changing norms and behavior in ways that might be unthinkable in the private sector. In the long run, the Military-Environmental Complex and the relationships it both builds upon and engenders between the military and the private sector could have important consequences not only for the development and commercialization of clean energy technologies that have widespread civilian applications, but also for the diffusion of environmental practices into the broader population.

### Solvency – Navy Demand

#### The Navy is a suitable actor for procuring biofuels

Mason 14 (Sarah Mason, Arizon State University Light Works) May 29, 2014 “US Navy Supports ASU’s Development of Algae-Based Biofuels”

http://advancedbiofuelsusa.info/us-navy-supports-asus-development-of-algae-based-biofuels

The similarities between the U.S. Navy and civilian cities and industry may not be readily apparent, said Dennis McGinn, U.S. Navy Assistant Secretary for Energy, Installations and Environment, but in the realm of energy use and reliability, there are often parallel problems to be solved. Where there are overlapping issues, such as cost, sustainability, efficiency and energy security, McGinn said the Navy is interested in working with research institutions and industry to improve the energy outlook for all.¶ …¶ As part of his visit to ASU, McGinn toured the Arizona Center for Algae Technology and Innovation (AzCATI) at the Polytechnic campus in Mesa. As the largest university-based algae facility on the globe, AzCATI leads the DOE-funded national algae testbed, the Algae Testbed Public-Private Partnership (ATP3). The Navy has interest in the work done by AzCATI and ATP3, especially if the cost of creating algae biofuels can shrink to compete with traditional fuel markets, McGinn said.¶ …¶ “Globally, there is a continuing overreliance on fossil fuel. And while we are very appreciative and view it as a blessing to our country to have this current oil and gas boom, in the national security business we get paid to look over the long-term horizon,” said McGinn. “When we look 15 or 20 years out into the future, we see significant potential for great competition, and even conflict, related to increasing world demand for petroleum.”

### Solvency – Spillover

#### Military innovation spills over to the public sector

Sauter et al 13 (Michael B. Sauter, Alexander E.M. Hess, Thomas C. Frohlich) August 20, 2013 “Government issue innovation”http://money.msn.com/investing/5-famous-products-invented-for-the-military

While most people think private enterprise is responsible for innovation, a great deal of the technology Americans rely on comes from another well-known source: the U.S. military.¶ Over the years, the military and the private contractors it works with have created some of the most important products we use today. Some of the inventions have been less groundbreaking than others, such as Silly Putty and Aviator sunglasses. But military research also led directly to significant innovations such as the microwave oven and the GPS. Private companies developed most of the products on this list, often answering the military's call during wartime. And in many cases, the ultimate use of the product completely differed from its intended military function. For instance, Silly Putty was invented as a possible substitute for rubber, and while it failed in this regard, it became a popular toy.¶ The military also played a part in developing even greater technologies. ARPANET, widely considered to be a precursor to the modern Internet, was a military program designed to share documents securely between facilities. In the 1940s and '50s, the military even played a role in the development of the modern computer.

#### The Military has had success in creating spillover

Menconi, 11

(Keith Menconi, The Epoch Times, “The Military: Unlikely Advocate for Green?,” September 18, 2011, http://www.theepochtimes.com/n2/opinion/the-military-unlikely-advocate-for-green-61738.html)

If the military does maintain a strong commitment to clean energy, it can play a unique role in the development of viable biofuels and other reduced carbon emissions sources. The Center for American Progress argues, “The military can test various advanced biofuels to determine the most effective blend before they are commercialized. And it can do this more easily than private businesses because it can afford to experiment without concern about a short-term profit.” With increased, stable demand, prices will drop and the industry will expand. Many biofuels have only dubious credentials as friends of the environment. Thankfully, the Navy reports that it will not use corn as a fuel source, nor any other fuel that would diminish the food supply. The Navy is in fact mandated to only use fuels with lifecycle costs and emissions that are lower than traditional fossil fuels. Military investment could also help develop green technologies. Many commentators point to GPS as an example of a technology initially developed for the military that gained a second life in civilian applications. Thomas Hicks, Deputy Assistant Secretary of the Navy, recently argued that we are unlikely to anticipate the most important technological transfers, but did speculate that sensors capable of detecting heat loss could be a likely candidate for one of these transformative cross-over technologies. He noted that military investment in this technology has dropped the cost of development substantially and has made it more likely that civilian applications could become economically viable. There is another potential spillover effect that a successful military greening project could offer. The military is a nationally recognized organization with great prestige, giving its energy efficiency initiative the potential to legitimize going green and even to broaden recognition of the dangers of climate change. At a recent congressional briefing on the Defense Department’s Deployment of Energy Efficiency and Renewable Energy, Richard Kidd, deputy assistant secretary of the Army, Energy and Sustainability, argued that the military has historically led the nation toward broader acceptance of some of its most controversial social issues.

#### CP will spillover to private industry

Harder, 13

(Amy Harder, Harder covers energy policy for The Wall Street Journal., National Journal, “Navy’s Use of Biofuels Could Trigger Private-Sector Adoption,” August 15, 2013, http://www.nationaljournal.com/daily/navy-s-use-of-biofuels-could-trigger-private-sector-adoption-20130815)

The Navy's use of advanced biofuels could help spur private-sector investment, said Dennis McGinn, President Obama's newly confirmed assistant secretary of the Navy for energy, installations, and environment. "The private-sector benefits are the military's ability to do some pretty good analysis, to manage risk, and to introduce innovative materials and innovative processes," said McGinn, who was confirmed by the Senate earlier this month before the congressional recess. "It significantly lowers the barrier of entry to new industries and new technologies." From medical devices to space technology, the Pentagon has often been an incubator for the private sector. McGinn said he's going to work to make sure it's the same in the renewable-energy sphere, and especially for biofuels. "It can have a catalytic effect for large consumers of transportation," said McGinn, who stepped down recently from his post as president of the American Council on Renewable Energy when the Obama administration courted him for this position.

### Solvency – Aviation

#### Military investment leads to commercialization – that spills over to the aviation industry

Woody 12

(Todd Woody, 9/06/2012, Forbes, “The U.S. Military's Great Green Gamble Spurs Biofuel Startups”, http://www.forbes.com/sites/toddwoody/2012/09/06/the-u-s-militarys-great-green-gamble-spurs-biofuel-startups/2/)

Eighty miles west of El Paso, Tex., in a sunburned stretch of the New Mexico desert, Predator drones and blimps patrol the nearby border and immigration-agency SUVs speed through the desolate terrain, the occasional coyote loping across the scrub. Oddly, given that I’m more than 600 miles from the Pacific, there’s a distinct salty ocean tang wafting on the breeze. But that’s not the sea I’m smelling: The odor is emanating from algae growing in 30 acres of huge oblong ponds at Sapphire Energy’s Green Crude Farm. Funded with $85 million from Bill Gates and other investors – plus $104 million in government cash and loan guarantees – the world’s only commercial outdoor algal biorefinery went online this summer and will eventually expand to 300 acres. The plan: extract 1.5 million gallons of green crude oil a year from patented pond scum fed a diet of carbon dioxide and sunlight. Even before San Diego-based Sapphire broke ground on the demonstration plant last year, the U.S. Navy’s green energy warrior, Vice Admiral Philip Cullom, descended on the desert site to grill Sapphire execs on their technology and its potential to fuel battleships and jet fighters. “No question, the military has focused the company and given us a great challenge to meet,” says Sapphire executive Tim Zenk, standing on the catwalk of a tank where a mechanical arm is harvesting thick green goo pumped in from the algae ponds. Scum ponds in the desert? The very idea conjures memories of the federal government’s decidedly mixed record at promoting alt-energy projects: Solyndra, FutureGen, A123′s electric-car batteries, synfuels in the 1980s, jojoba in the 1970s. Add to that all the many military boondoggles – Star Wars missile defense, for one – born of best intentions and bloated budgets. Sapphire has yet to earn a dime from the Pentagon; the company’s government funding comes from the Departments of Energy and Agriculture. But since the days when the startup’s scientists were still tinkering in the lab, they’ve been sending their biofuel for evaluation to the Defense Department, the deepest-pocketed client of them all. “There’s no other entity that has the capacity, the planning, the commitment and the policy drivers to make technologies real and create a market,” says Zenk. The U.S. military, the nation’s single largest oil consumer, wants to wean itself from petroleum, and is deploying its immense buying power and authority to commercialize nascent technologies deemed to be in the national interest. The Navy, which aims to get half of its energy from renewable sources by 2020, has been buying biofuels in small but expensive quantities, as in four times the cost of conventional fuels. Earlier this year the Pentagon invoked the Defense Production Act to solicit proposals to build at least one integrated biorefinery with $210 million in government funding. The biofuel buy has outraged some congressional Republicans, who are attempting to bar the military from purchasing any fuel that costs more than petroleum. It will be years before we know if the military’s biofuels bet is a multibillion-dollar folly – or if the armed forces have planted the seeds of another global industry, as it did with nuclear power, semiconductors and the Internet. This much is certain: The Pentagon’s largesse is already spurring the entrepreneurial zeal of startups like Sapphire that seek potential riches in shaping green technology to meet military needs. For a first-hand look at that opportunity I find myself onboard a Navy C-2A Greyhound in July approaching the USS Nimitz some 45 miles off Oahu. I’m strapped into a backward-facing seat wearing a survival vest and a “cranial” – Navy-speak for a helmet equipped with sound-deadening headphones and goggles. The roar of the transport’s twin props ratchets up and an airman in the last row of the dimly lit cabin starts pumping his arm wildly. “Go! Go! Go!” That’s the signal to brace for landing. As the Greyhound drops toward the 1,100-foot deck of the aircraft carrier, the pilot throttles up to 150 miles an hour. We shoot across the tarmac until a hook embedded in the plane’s fuselage catches a cable, whiplashing us to a dead stop. It was a short but historic flight from Honolulu, the first biofueled Navy transport to land on an aircraft carrier. We flew on algae and used cooking oil mixed in a 50-50 blend with standard petroleum aviation juice. Some 450,000 gallons of that biofuel, produced by Silicon Valley’s Solazyme and Dynamic Fuels, is also powering the 71 aircraft on deck – the F/A-18 fighter jets screaming across the blue skies above us, the E-2C Hawkeyes patrolling the surrounding airspace and the Seahawk helicopters ferrying Secretary of the Navy Ray Mabus and top Navy brass between two biofueled destroyers and a guided missile cruiser steaming alongside the nuclear-powered Nimitz. Algae being harvested at Sapphire Energy's Green Crude Farm in New Mexico. This is the Great Green Fleet, the first Navy strike force powered by biofuels and a two-day demonstration of Mabus’ determination to permanently float an energy-independent flotilla by 2016. “We’re moving forward and we’re not going to let up,” says Vice Admiral Cullom, the deputy chief of naval operations for fleet readiness and logistics. It’s not just about biofuels. The Marines are tapping solar and other technologies to make battlefield bases in Afghanistan energy independent and more impervious to enemy disruptions of supply lines that have extracted a high price in blood and treasure. And the Army in August opened bids to buy $7 billion in renewable energy to make its domestic bases less vulnerable to power grid disruptions. Algae is one of the great green hopes for creating a biofuels industry that can reach the scale necessary to bring down costs and compete against fossil fuels. Whether grown in bioreactors or in desert ponds, algal oil mostly sidesteps the food and land conflicts that potentially can limit other biofuels. It’s largely about bioengineering, hence Solyazme’s headquarters in the biotechnology corridor of South San Francisco. Founded in 2003 by Jonathan Wolfson, a financial entrepreneur, and genetic microbiologist Harrison Dillon, Solayzme began talking to the Department of Defense in 2007. “At the point when you’re still in test tubes and shake flasks, you’re thinking to yourself, ‘Ok, we need catalysts to continue to advance this technology,’ ” says Wolfson, sitting in a conference room that features a large framed photo of a Navy ship that steamed down the West Coast burning Solyazme’s algal oil. “As a technology-driven company we needed discipline to become a production company. And there’s no organization that I can think of that can drive more discipline into an organization than the DOD.” Solazyme grows heterotrophic algae in bioreactors. The algae consume sugar and excrete crude oil. After Solazyme began supplying the military with small quantities of algae biofuels for evaluation, the DOD awarded the company its first significant contract in 2010. The next year a United Airlines 737 flew the first commercial biofueled flight on Solayzme’s Solajet fuel. A contract with Volkswagen followed. ”The fact that we could even make that United flight was a direct result of the work we had been doing with the Navy,” says Wolfson. The military work also prompted discoveries of new strains of algae, which explains why next to its research labs Solazyme built a kitchen to bake up batches of chocolate chip cookies, honey mustard dipping sauce and crackers. While testing strains, Solazyme scientists found one that produces what tastes remarkably like olive oil but is healthier and could replace eggs and butter in a smorgasbord of foods. “Your mouth recognizes it as fat, but it has a remarkable reduction in calories and eliminates saturated fats,” says Genet Garamendi, Solayzme’s vice president of corporate communications, biting into an algae-infused cookie that beat Mrs. Fields’ hands down in an impromptu taste test. Solazyme struck a deal to commercialize its Betty Crocker crude with Roquette, the French food conglomerate. Other Solazyme strains are being produced for cosmetics and the company signed an agreement with Unilver to use its algae oil in consumer products. In May, Dow Chemical said it would tap a strain of Solazyme algal oil for use in electrical transformer insulating fluids. The commercial aviation industry is eager to become a major buyer of biofuels as a hedge against oil price spikes that can wipe out years of profit. But cash-strapped airlines are counting on the military to get production rolling. “There’s not a single commercial-scale facility up and running today and we’re all keen to see what happens to price and supply when you have commercial quantities in production,” says Jimmy Samartzis, United Airlines managing director of global environmental affairs and sustainability, referring to the Defense Department’s move to bankroll biorefineries.

### Solvency – Algae

#### Navy procurement of algae biofuels drives down cost

Lieutenant Alaina Chambers (US Navy) and Steve Yetiv, 2011, Naval War College Review, “The Great Green Fleet,” <https://www.usnwc.edu/getattachment/72d7de2c-b537-4466-9b4b-809c205d1747/The-Great-Green-Fleet--The-U-S--Navy-and-Fossil-Fu>

The Navy and other services are setting good examples by actively seeking energy¶ solutions, in spite of skepticism and political controversy. Their programs¶ can help spur similar efforts in other agencies and the private sector, but they¶ still only represent a small percentage of the country’s total consumption. Nonetheless,¶ the Navy’s experience offers some broader lessons and synergies, beyond¶ oil dependence. For instance, as we have seen, DoN is innovatively pursuing renewable¶ sources of electricity generation. Such power could produce needed¶ electricity in the future when demand outstrips supply; simply pursuing alternative¶ fuels, as such, is counterproductive if it means increased dependence on¶ electricity generated by such sources as coal. The Navy’s pursuit of multiple avenues¶ for not only alternative fuels but renewable energy technology merits¶ attention.¶ Electricity generated by sustainable methods could also help run a much¶ larger fleet of electric vehicles. Indeed, creating more electricity does little to decrease¶ oil dependence, because, as noted, Americans (and others around the¶ world) put the bulk of their oil into their gas tanks. Electricity (whether solar,¶ wind, nuclear, coal, or whatever) does not do much to decrease fuel consumption.¶ We can’t put electricity in a gas tank. However, studies show that a vehicle¶ fleet of “plug-ins” could achieve mileages over eighty-four miles per gallon,¶ compared to America’s present average of twenty-three. In this way, used to run¶ a national fleet of vehicles, electricity could in fact decrease oil consumption. In terms of synergies, it may be that the Navy’s research into alternative energies¶ such as algae may dovetail with similar efforts under way in academic and business¶ circles. Indeed, the Navy is a great laboratory for testing the value of algae-based approaches.¶ One challenge of such approaches is to reduce costs relative to oil, partly¶ by decreasing how much energy is used to operate them and partly by increasing¶ their energy output. Progress in both areas might be achieved more effectively¶ through greater cooperation among the Navy and academic and business actors.

### Solvency – AT No Diffusion/International Modeling

#### The military will allow the tech to be diffused due to its concern about global warming

Sarah Light, December 2013, (Assistant Professor of Legal Studies and Business Ethics), The Wharton School, University of Pennsylvania, “The military-environmental complex,” <http://ppi.wpengine.netdna-cdn.com/wp-content/uploads/2012/11/issue-brief_V1_N12.pdf>

Third, successful dissemination of technological innovation beyond government agencies also requires openness, rather than secrecy. Thus, to the extent that the military is driving innovation, policymakers should make sure that the policy and legal landscape promote diffusion regarding technologies that can reduce conventional energy demand and develop renewables, rather than holding such technology close to the vest in the name of national security. Given the military’s role as a validator of climate science, and its recognition that climate change has the potential to increase violent conflict in the world, diffusion is likely to be in the military’s interests in this context. In this vein, the DoD and the private sector should create more platforms for sharing best practices, experience with new technology, and information regarding potential opportunities for private firms to invest in innovation. As centers of innovation both in technology and ideas, universities are ideally situated to serve as mediators in this important dialogue.

### Politics Net Benefit

#### Military procurement of alternative energy is insulated from politics

Lieutenant Alaina Chambers (US Navy) and Steve Yetiv, 2011, Naval War College Review, “The Great Green Fleet,” <https://www.usnwc.edu/getattachment/72d7de2c-b537-4466-9b4b-809c205d1747/The-Great-Green-Fleet--The-U-S--Navy-and-Fossil-Fu>

DoN’s alternative-energy strategy has been criticized as overambitious. Some of¶ these criticisms deserve consideration. After all, some of the new energy technologies¶ discussed here are still in their infancy and face significant technological¶ hurdles; others are prohibitively expensive at present and are many years¶ away from being serious competitors to oil. Many of the alternatives, such as nuclear¶ power, reduce carbon emissions but present environmental challenges of¶ their own, such as waste disposal. These impediments will, in the short term,¶ make a switch to alternative energies difficult without significant incentives and¶ visionary leadership. In any case, careful, comparative cost-benefit analyses are¶ necessary.¶ However, with these caveats in mind, the move toward green energies and alternative¶ technologies appears to be quite positive. The U.S. Navy is a sensible¶ laboratory for testing and advancing these energies. Indeed, the American public¶ is still divided on the subjects of climate change and fossil-fuel dependence,¶ and that makes it harder for Congress or the president to implement effective¶ market-stimulus measures. The U.S. military culture, though bedeviled by its¶ own bureaucratic politics, is somewhat insulated from civilian political deadlock¶ and the demands of public opinion; at least, its officials do not have to seek¶ reelection.

#### Doesn’t link to politics-massive congressional support for military biofuel

Weinstein 13

(Adam Weinstein, March/April 2013, Mother Jones, “How the Military Repelled the GOP's Biofuel Attack”, http://www.motherjones.com/environment/2013/02/biofuels-military-great-green-fleet)

Last summer, it looked as if the Great Green Fleet—and, for that matter, the military's entire biofuel push—was dead in the water. Ticked off by what they said were exorbitant costs and misplaced security priorities, conservatives in the Senate vowed to sink the plan. "Adopting a 'green agenda' for national defense, of course, is a terrible misplacement of priorities," Sen. John McCain (R-Ariz.) told reporters last May. Sensing an opportunity to knock President Obama on his national-security cred and extend a Solyndra-style "green cronyism" narrative, his wingman, Sen. James Inhofe (R-Okla.), succeeded that summer in slipping an amendment into the defense budget that would block the Navy from spending any money on biofuel. But in the aftermath of Obama's reelection, the Senate revolted against Inhofe: 11 Republicans joined 49 Dems and two independents in killing his amendment in late November. "Rather than placing roadblocks in front of the Navy's plans, Congress should help it in its effort," Sen. Susan Collins (R-Maine) wrote in a Politico op-ed with Sen. Jeanne Shaheen (D-N.H.). "When's the last time 62 senators agreed on anything?" says Michael Wu, director of Operation Free, a clean energy and security campaign that lobbied against the amendment. It was the latest episode in the through-the-looking-glass universe where admirals, generals, and defense contractors go mano a mano with conservative politicians to push a green agenda. This green/camo coalition deploys the same kind of spin and pork barrel maneuvering used to justify budget-busting planes and tanks—only it's about running military engines on algae, seeds, and used French-fry oil. The biofuel initiative is "not only essential for continued military operations," says Wu, summarizing the argument that swayed Congress, "it's also in the national economic interest. That really got to Republicans, especially those in the Southeast with biomass potential, and the Midwest with agricultural centers." Trade groups also got in on the action, Wu notes, seeing the military's renewables venture as a proving ground for their own interest in biofuels: "There is a lot of interest from the private sector. Fuel costs are 35 percent of the overhead for the airlines, and they have a very narrow profit margin."

## Open Ponds CP

### 1NC

#### The United States federal government should substantially increase its financial incentives for algae-based biofuels produced via an “open-pond” method in the United States.

#### The open pond method is better than bioreactors

Sieg 10 (David Sieg. Building Open Ponds. Information Specialist Corp. June 2010.)JC

**Growing algae in open ponds means construction costs are cheaper than** [**photobioreactors,**](http://www.growing-algae.com/algae-photobioreactor.html) **and at a minimum requiring only a trench or pond.** **Large ponds have the largest production capacities relative to other systems of comparable cost.** Also**, open pond cultivation can exploit unusual conditions that suit only specific algae**. For instance, [Spirulina sp.](http://www.growing-algae.com/spirulina.html) thrives in water with a high concentration of sodium bicarbonate and Dunaliella salina grow in extremely salty water. **Open culture can also work if there is a system of culling the desired algae and inoculating new ponds with a high starting concentration of the desired algae.**

### Solvency

#### Open Ponds are Best Solution

Austin, 2010, Anna Austin. Biomass Magazine associate editor. “Open Ponds Versus Closed Bioreactors.” Biomass Magazine. .)JC

**The** U.S. **DOE**'s National Renewable Energy Laboratory concluded in 1990 in its Aquatic Species Program close-out **report that open raceway ponds were the most viable solution for the mass production of algae for conversion into biofuels, but that it was much too early to determine whether open, closed or hybrid designs of growing algae would ultimately prevail**. Generally, open ponds have been associated with contamination issues, excessive space requirements and limited location possibilities due to climate. At the same time, closed **bioreactors have mainly been considered too expensive.** There wasn't much room for doubting the accuracy of NREL's report, but have technological advancements in the past two decades leveled the playing field? Perhaps, but companies today pursuing either route still face the same hurdles their predecessors did. Whether it takes five, 10 or 20 years, the key to economic algae-based biofuel production is developing the most cost-effective growth model possible. If light limitation is the main problem in achieving the commercial potential of algae in scaled commercial cultivation operations, Massachusetts-based Bodega Algae may have the solution, according to CEO Joseph Dahmen. In January, Bodega Algae and Bigelow Laboratory for Ocean Sciences in West Boothbay Harbor, Maine, received a six-month, $150,000 Small Business Innovation Research grant from the National Science Foundation to develop and test a prototype for growing high concentrations of algae for use as biofuel. More specifically, Bodega will use the funds to develop advanced photobioreactors, and is making "big advancements," Dahmen says. Bodega Algae will work on the grant with Bigelow Laboratory for Ocean Sciences in West Boothbay Harbor, Maine.

### Solvency – Better than PBR

#### **Open Ponds More Economic than PBR**

Richardson 12 (James W. Richardson. Texas A&M University with the Department of Agricultural Economics. “Economic comparison of open pond raceways to photo bio-reactors for profitable production of algae for transportation fuels in the Southwest” *Science Direct*. April 1, 2012.)JC

**As energy prices climb there is an increasing interest in alternative, renewable energy sources. One possible source of renewable bio-fuel is algae**. This research uses a multi-year, Monte Carlo financial feasibility model to estimate the costs of production and chance of economic success for commercial size algal biofuel facilities in the Southwest. **Capital and operating costs and productivity information from Davis et al. were used to develop parameters to define and simulate two types of algae production systems; open pond and photo-bioreactor (PBR**).¶ **The financial feasibility of PBRs is substantially lower than for open ponds.** In the base case, average total costs of production for lipids, including financial costs, were $12.73/gal and $31.61/gal for open ponds and PBRs, respectively. The chance of economic success for the base situation was zero for both open ponds and PBRs. **The financial feasibility analysis showed that the only way to achieve a 95% probability of economic success in the PBR system was to reduce CAPEX by 80% or more and OPEX by 90% or more. For the open pond system there were several options that could return a 95% or greater chance of economic success, for example, reducing CAPEX by 60% and OPEX by 90%.**

#### Open ponds are cheaper than bioreactors

Rodolfi et al. 8 Microalgae for Oil: Strain Selection, Induction of

Lipid Synthesis and Outdoor Mass Cultivation in a

Low-Cost Photobioreactor dep of biotechnology and bioengineering France

A possibility to signiﬁcantly reduce capital and operating¶ costs of microalgae cultivation would be using raceway¶ ponds. Plastic lined, paddle-wheel mixed raceway ponds¶ are much less expensive to build and operate than PBR (but¶ see Chisti, 2007 for a different opinion). Raceway ponds¶ were developed in the 1950s, ﬁrst in Germany and Japan,¶ then in the USA and extensive experience exists on their¶ operation (Richmond, 1986). These open-air systems, of¶ maximum size of a third of a hectare, may be built in¶ concrete or compacted earth and lined with cheap plastic¶ (Tredici, 2004). Both cooling, achieved by evaporation,¶ and mixing by paddle wheels require low energy inputs¶ per unit area (Richmond, 1986), and a recent life cycle¶ analysis suggests that microalgae cultures in raceway ponds¶ might have a largely positive energy balance (Huesemann¶ and Benemann, in press). However, open systems suffer¶ from a severe limitation, also emerged during the Aquatic¶ Species Program (Sheehan et al., 1998): contamination¶ with unwanted algae and other organisms is inevitable in¶ long-term operation and translates into the impossibility of maintaining the desired microalga in culture long enough,¶ unless species that tolerate extreme conditions, such as¶ Dunaliella or Arthrospira, are cultivated (Tredici, 2004). With the exclusion of these few examples, microalgae¶ cultures in open ponds are very unstable ecosystems, affected by large diurnal and seasonal variations of physic-¶ chemical and biological parameters that lead to frequent¶ changes in the community population structure

### Solvency – Economically Viable

#### Open Ponds can Maximize Economic Viability

Hannon et. al. 11 (Michael Hannon, Javier Gimpel, Miller Tran, Beth Rasala, and Stephen Mayfield, San Diego Center for Algal Biotechnology, University of California San Diego, Division of Biology. “Biofuels from algae: challenges and potential.” *US National Library of Health*. August 8, 2011)JC

**Optimizing the growth of algae in open ponds is a key component of reaching economic viability,** and remains a major challenge for the industry. Identifying species that grow well under these conditions is a focal point of research in many laboratories. **Algae can grow in a wide variety of temperatures, with growth being limited primarily by nutrient availability and light. Light provides the energy for carbon fixation, and is converted to chemical energy through photosynthesis, providing the building blocks for biofuel production.** **Algae growth rates are often limited by light penetration into the ponds from both self-shading and light absorption by the water, and these constraints are major determining factors of pond depth.** The identification of production species that have adapted to harvest shorter wavelengths of light, which have greater water depth penetration, may allow algal pond depth to be increased beyond the current 15–30 cm [106]. **This will decrease the total land required for algal biofuel production.**

### AT Land Use

#### There is enough land to produce algae biofuels

FAO 9 [Food and Agriculture Organization of the United Nations May 2009 http://www.fao.org/fileadmin/templates/aquaticbiofuels/docs/0905\_FAO\_Review\_Paper\_on\_Algae-based\_Biofuels.pdf](file:///C:\Users\Real%20Debate\Documents\Food%20and%20Agriculture%20Organization%20of%20the%20United%20Nations%20%20%20May%202009%20http:\www.fao.org\fileadmin\templates\aquaticbiofuels\docs\0905_FAO_Review_Paper_on_Algae-based_Biofuels.pdf) “ALGAE-BASED BIOFUELS: A Review of Challenges and Opportunities for Developing Countries”

Because algae are grown in water, the cultivation systems have much lower land quality requirements then agriculture. Soil fertility is not an issue at all. Land needs to be relatively level and sufficiently solid to build the cultivation systems on, which still allows a huge area of land to be used, such as deserts, infertile saline soils, polluted land and other land with low economic (and ecologic) value. As an example, Glenn et al. (1998) indicate that 43 percent of the earth’s total land surface is arid or semi-arid and estimate that 15 percent of undeveloped land has sufficient access seawater (max 100 km), which amounts to 130 million ha. Furthermore, Bai et al. (2008) estimated that 24 percent of the earth’s total land (about 3 500 million ha) has been degrading over the last 25 years. Part of the world’s deserts further away from the sea may have saline ground water that could be used, or access to wastewater or sufficient fresh water. There is an enormous amount of land suitable for ABB production, that does not compete with agricultural land and avoids conversion of land with high carbon stocks. Much of the infertile land area overlaps receives high amounts of sunlight, compare the yellow land area in Figure 5 with sunlight levels in Figure 4.

### AT Water Use

#### There is enough water to support algae production on land

**Green Car 13** May 22, 2013 <http://www.greencarreports.com/news/1084336_u-s-perfectly-placed-for-algae-based-biofuel-production> U.S. Perfectly Placed For Algae-Based Biofuel Production Green Car Reports is the place car shoppers turn to for help deciphering the world of "green" cars, reporting on which ones benefit the Earth, and which don't do as well

The discovery comes from the U.S. Department of Energy's Pacific Northwest National Laboratory(PNNL), which looked in-depth at the water resources needed to produce suitable amounts of algae for the production of biofuels. Algae grows best in areas of plenty of sunlight and water. To provide the stable conditions allowing the algae to grow best, warm weather and a humid environment are also preferred. That makes the U.S. Gulf Coast perfect, not least for its abundance of water. Biofuel research [has turned towards algae](http://www.greencarreports.com/news/1035047_want-to-go-even-greener-power-your-prius-on-algae) in recent years after the discovery it has the ability to generate oil, which can then be turned into fuels. Better still, it's abundant on a truly enormous scale, and doesn't bring with it the issues courted by biofuels from crops, which are accused of diverting resources needed for important food crops to fuel production. The potential is huge, though so are the resources needed to produce such quantities of algae solely for fuel. Water is the chief requirement, the scientists estimating that water use would equal one quarter of the quantity currently used by agriculture. That's an enormous amount, but the study does point out that the water could come from virtually anywhere, including fresh or salty groundwater, and seawater. Plenty of land would also be required, with each 'algae farm' setting aside several pools of six to 15 inches deep, though again the study suggests there's land to spare for such a task. Ultimately, the PNNL's study quotes estimates, rather than hard figures, but if such a system was put into place it could drastically reduce the U.S.'s oil imports.